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# Science & Technology

## Central Eurasia:
## Electronics & Electrical Engineering

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# Science & Technology
## Central Eurasia: Electronics & Electrical Engineering

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## Simple Efficient Antennas for Long-Distance Links

[Article by G. Bolotov]

[Abstract] A new type of simple and efficient antennas for transmission of international sport events has been created by the UZ3QBM Broadcast Listener (DXer) group, the fruit of long experimentation. They are vertical stub antennas with radiators resembling wave dipoles, each $5\lambda/8$ long radiator connected in series with an inductance coil to a total $3\lambda/4$ total electrical length, and with $\lambda/4$ long radial counterweight conductors. Three experimental antennas were built and tested: 1) for the 14 MHz frequency band (stub 13.2 mm long with 32 mm median diameter, counterweight conductors 5 x 5.3 m long, coil with 11 turns of 4 mm gage wire 35 mm in diameter), 2) for the 21 MHz frequency band, 3) for the 28 MHz frequency band. On the basis of their design and performance analysis were then built two operational antennas for radio sport amateurs operating in the 14 MHz frequency band (minimum VSWR = 1.0 at 14.15 MHz, VSWR = 1.15 at 14.0 MHz, VSWR = 1.2 at 14.3 MHz) and in the 7 MHz frequency band (minimum VSWR = 1.05 at 7.06 MHz, VSWR = 1.2 at 7.0 MHz, VSWR = 1.3 at 7.1 MHz). In the case of space limitation, the design of these antennas requires some tradeoffs and thus sacrifice of some performance characteristics. Figures 2.

## Code Lock With Single-Button Control

[Article by V. Baranov]

[Abstract] An electronic lock operating by a protect code is described which contains a minimum number of microcircuits and uses preferably a sequence of digits equivalent to 4 or 8 decimal ones so as to ensure an only $10^{-8}$-$10^{-4}$ probability of its unauthorized chance selection. The lock is controlled by one button and operates with the master counter initially in the "0" state, whereupon selection of a digit coinciding with the assigned code digit causes the counter to shift up by " 1". Selection of a digit not coinciding with the assigned code digit causes the counter to either remain in its "0" state or shift back to it. Only if the entire sequence of code digits has been selected correctly, will the counter shift into a state which allows opening the lock. The lock contains two triggers, one binary counter, a multiplexer, a demultiplexer (identical another binary counter), a decoder of the demultiplexer state, and an attempts counter. It contains two transistors, one diode, and one light-emitting diode. Another version of such a lock also contains an 8-digit logic circuit with eight diodes. A door lock controlled by this code lock can be opened by a conventional key, but movement of the bolt is restrained by a spring-loaded detent-clapper of an electromagnetic relay in the open position. Only upon application of a voltage to the electromagnet coil, will the detent-clapper drop to close the relay and thus release the lock bolt. Figures 4; reference 6.

## Keyboard "Elektronika MS700" in "Radio-86RK"

[Article by B. Frolkin and A. Makarov]

[Abstract] The keyboard MS7007 used with "Elektronika" computers at the Ukrainian Science Center can also be used with "Radio-86RK" computers used by radio amateurs. The hookup circuit contains eight diodes, 13 resistors, two capacitors, two light-emitting diodes with a quenching resistor each, and two rosettes. The driver is placed in the read-only memory of the monitor. No additional printed-circuit boards and connectors are needed. It is only recommended that the following inscriptions on keys be changed: from [FIKS] to [RUS/LAT], from [ALF] to [US], from [POM] to [PS], from [SBROS] to [STR], from [UST] to [arrow pointing upward at a 45° angle to the left]. These changes are not absolutely necessary, it suffices to replace the [FIKS] and [ALF] tabs. Figures 2; references 2.

## Microcircuit K148UN1 Under Low Supply Voltage

[Article by A. Vasilyev]

[Abstract] The microcircuit K148UN1 is a low-cost audio-frequency amplifier. Its integral metal enclosure ensures excellent heat dissipation, which contributes to high efficiency and reliability. It requires a bipolar +/-12 V power supply and is designed for a 30 $\Omega$ load, which makes it hardly suitable for radio amateur sets. Using this microcircuit, however, the author has designed an audio-frequency amplifier for a conventional dynamic head with an 8 $\Omega$ DC resistance which requires only a 9 V power supply. The amplifier draws not more than 0.4 mA at the quiescent point and can deliver a maximum power as high as 0.9 W, the ripple factor depends on both the output power and the operating frequency. Experiments have revealed that under such low voltage the microcircuit operates as a class B amplifier, but without audible "droop" distortions when the voltage gain does not exceed K = 12 (K = 100-200 in a standard configuration). The voltage gain is controlled by means of two resistors and is equal to the ratio of their values plus 1. Frequency correction is effected by means of a capacitor. Stability is achieved by absence of frequency-dependent negative feedback and presence of a decoupling R-C filter. When correctly assembled, the amplifier does not require adjustments. It remains operative within the 5-10 V range of supply voltage. Figures 1; references 1.

## Radio Amateurs and Sport: "Druzhba(Friendship)-91" Games

[Article by G. Shulgin]

[Abstract] A friendship between the sport teams of the two sister cities Kharabovsk (USSR) and Portland (Oregon, USA) began during their "Druzhba-89" games taking place in Khabarovsk, the first ones ever broadcast over Soviet radio. A group of Soviet radio amateur sportcasters subsequently went to the United States for the "Druzhba-91" games in Portland and Seaside. Much time between events, which they broadcast home, was spent on scheduled conferences and informal discussions with their American hosts. In three days they learned a great deal about American conduct of sporting events, about American sportcasting technique, and about short-wave radio equipment available to American radio amateur sportcasters. They departed for home in a state of exhaustion and elation, looking forward to another get together with their American counterparts. Figures 1.

## This Took Place in the Persian Gulf

[Article by V. Vasilyev]

[Abstract] Radioelectronic warfare before and during the Desert Storm operation in the Persian Gulf is evaluated, following a survey and brief description of ground and airborne radioelectronic and optoelectronic equipment: for reconnaissance and target tracking, for aircraft and weapons guidance, and for military intelligence. Western sources report that the United States lost 140 military personnel and four tanks while Iraq lost 2500 tanks, many even when they were still camouflaged before being pulled into combat position. Especially effective in combat were the "Copperhead" missiles, which operated with laser guidance and television monitoring systems. Less successful were the "Patriot" missiles, sometimes failing to destroy the target and in one case, fragments hit civilians on the ground. Figures 4.

## Digital Processing of SSTV Signal

[Article by Ye. Sukhoverov]

[Abstract] Conversion of an analog slow-scan television signal to a digital one is considered as a way to simplify processing and storage of video information. Time discretization and level quantization converts an analog signal into a sequence of pulses each carrying an information quantum, the Kotelnikov-Shannon theorem stating that the discretization frequency must be at least twice the highest signal frequency. This determines the least number of elements and luminance grades into which an SSTV image needs to be decomposed. In modern SSTV systems a frame consists of 128 x 128 elements with as few as four or as many as 16 grades of luminance. A parallel-action analog-to-digital converter composed of high-speed comparators, one less than the number of luminance grades, generates a position code which an encoder then converts into a a binary or preferably a Gray code. The digital SSTV video signal is stored in a dynamic random-access memory, which in addition to record and read signals receives also synchronizing and forced recovery signals. A digital signal retrieved from the memory proceeds to a decoder which converts it into a binary code, this code then being processed by a digital-to-analog converter and the analog signal then being shaped into a complete television signal for appearance on the screen of a TV set. The technique has been extended to color slow-scan television signals, the first bilateral color SSTV link having been established across the Atlantic Ocean on 15 March 1980 between G3NOX and W9NTP with the QSO passing at a frequency of 29.150 MHz. In this event G3NOX used a black-and-white television camera and transmitted R, G, B fields sequentially "frame-by-frame" through appropriate light filters, while W9NTP transmitted using two-color signal separation in accordance with the NTSC standard. While "frame-by-frame" transmission of color signals is simplest and easiest, their "line-by-line" transmission requires a color television camera and conversion of the camera output signal into a sequence of R-G-B-R-G-B-... color lines for transmission in this form. The receiver of SSTV images must contain at least three pages of memory with an electronic commutator switch, the digital signals retrieved from that memory being converted and then shaped into a composite color television signal. Figures 5; tables 1; references 6.

## Radio Amateurs' Contributions to National Economy

[Article by B. Pavlov]

[Abstract] Inventions demonstrated at the 35-th All-Union Exhibition of Achievements in USSR National Economy held from 23 April to 17 May 1991 in Moscow include inventions made by radio amateurs, most of the medals and prizes having been awarded to residents of Minsk and Moscow. The Gold Medal was awarded to V. Abramov, instructor at the Minsk Higher Anti-Aircraft and Rocket Engineering School of Air Defense, for his "frequency drift meter" and "laser-type angular rotor displacement and vibrations meter". The Silver Medal was awarded to Ye. Uspenskiy (Moscow) for his "high-precision hydrometeorological air-temperature transducer bridge". A special prize was awarded to L. Umnov (Moscow) for his signal device for detection of "pirate" wire broadcast relayers. This device includes a comparator, an encoder, a notifify signal generator, a filter, a connect signal, and a power supply. A special prize was

awarded to V. Sidorovich (Minsk) for his device which records and graphically displays two dynamic processes simultaneously. A team under the leadership of V. Akhayev (Lvov) has invented a traffic information system which facilitates relaying music and speech from magnetic cassette through a microphone as well as reception and relaying of radio broadcasts. An electromagnetic interference-type thickness gage with a 1-110 mm range for nonmagnetic materials has been developed by V. Kotlyarov, O. Gubanov, and Ye. Sergiyenko (Lvov). The second prize in the "Radioelectronic Devices for Household and Service" Pavilion was shared by B. Bodnar and O. Starostenko (Lvov) for their "Golden Rooster" timer and S. Sakhnov (Novosibirsk) for his "telephone secretary and automatic responder". Other particularly interesting items exhibited by radio amateurs were the radioactivity detector invented by I. Yershov (Simferopol), the thermoacoustic bee swarm guide invented by V. Dukhonchenko (Zaporozhye), the milk quality analyzer invented by Yu. Bocharov and V. Lukinskiy (Ryazan), and the electronic game "Roulette" invented by O. Gerega (Ivano-Frankovsk). Figures 4.

## Products Offered by Industrial Association "Radiy"

*927K0189E Moscow RADIO in Russian No 10, Oct 91 p 91*

[Abstract] Latest products offered by the Industrial Association "Radiy" (Radion) are: 1) M55121-1/2/3/4/5/6 low-noise microwave (centimeter waves) receiver modules for amplification of weak signals and their conversion into intermediate-frequency signals; 2) ferrite microwave plane-of-polarization rotator for linearly polarized 10.95-11.75 GHz signals; 3) centimeter-wave polarization separator for separating horizontally polarized signals from vertically polarized signals during collective reception of satellite television and radio relay broadcasts. Figures 3.

## Radio Telephone for All: Problems and Accomplishments

*927K0106A Moscow RADIO in Russian No 6, May 91 pp 2-6*

[Article by Nataliya Kiy]

[Abstract] Introduction of a mobile radio telephone system in the Soviet Union is considered, the All-Union Radio Telephone Association estimating a potential market of 3-5 million automobiles and pedestrians. An "air channel" will furthermore, according to I.I. Dezhurnyy (chief engineer of land mobile radio service apparatus at the USSR Ministry of Communication, recipient USSR State Prize), relieve the desperate demand for scarce supply of cables and automatic telephone exchanges. A good model for this system is the one with a "honeycomb" territorial network layout successfully developed in the United States and in West Europe, with a base station within each "cell" and all

base stations connected through switching exchanges to the existing statewide telephone network. The range of a base station varies from 0.5 km to 40 km, depending on the size of the "cell" area. Most systems operate in both 450 MHz and 900 MHz frequency band, will operate in the 900 MHz frequency band after changeover to digital equipment. Such a system is ideally suited for the most heavily populated "cells" (Moscow, Leningrad, Voronezh, Urals, Donets Basin, and others). In order to also cover remote regions in Siberia and the Far East, I.I. Dezhurnyy proposes a zonal system based on population size and density distribution. The main central radio station within the population center is to be surrounded by zonal central radio stations at successively farther distances within successively less populated areas, radio extensions of telephone lines then to be available for hookup of individual car and "walking-talking" telephone sets. Various system variants and devices for person-to-person radio telephone communication have been proposed by winners of a nationwide competition. Specialists claim that joint Soviet-American and Soviet-American-Swedish corporations will most effectively build such a system in the USSR in accordance with the NMT-450N standard. Figures 3.

## On Broadcasting Wavelengths

*927K0106B Moscow RADIO in Russian No 5, May 91 pp 6-8*

[Article by S. Bunin]

[Abstract] Various groups of radio listeners have been formed since the 1930s, most prominent among the English-language listeners being the Broadcast Listeners or DXers (motto: "scientific hobby for better world communication, friendship, and good will between the peoples of the world") and the Short Wave Listeners. For those in the USSR there is available a S (signal strength) I (interference) N (static noise) P (propagation disturbance) O (overall rating table in each of these five parameters is graded on a 5-1 scale. Signal strength: 5 - excellent, 4 - good, 3 - medium, 2 - weak, 1 - hardly audible. Interference from other stations: 5 - none, 4 - weak, 3 - moderate, 2 - strong, 1 - very strong. Static noise: 5 - none, 4 - weak, 3 - moderate, 2 - strong, 1 - very strong. Propagation disturbance: 5 - none, 4 - faint fadeouts, 3 - moderate fadeouts, 2 - deep fadeouts, 1 - very deep fadeouts. Overall rating: 5 - excellent, 4 - good, 3 - satisfactory, 2 - poor, 1 - reception not possible. A "reception report" for exchange of information among listeners should include the time of reception time (UTC or GMT) and the frequency band, also a description of the receiver and antenna type. Reference is made to existence of MONITOR journal published in London (England) by the International Short Wave League and to bulletins published by other short wave clubs. The status of English-language short wave listening in the USSR is quite poor, mainly owing to the policy of the Soviet Government in the nineteen thirties and later to shield Soviet society from foreign propaganda. Inasmuch as matters have changed now, new opportunities are

unfolding to Soviet short wave listeners. A major problem is, however, that the radio receivers most widely used in the USSR neither have a calibrated dial nor are designed for shorter than 25 m (12 MHz) wave bands, while many far away stations and seldom broadcasting stations operate in 19-11 m wave bands. Figures 1; tables 1.

## New Commercial SECAM and PAL Decoders

*927K0106C Moscow RADIO in Russian No 5, May 91 pp 34-35*

[Article by L. Kevesh and A. Peskin]

[Abstract] This concluding Part 3 of the article on new commercial SECAM and PAL decoders (Parts 1 and 2 in RADIO Nos 3 and 4, 1991) covers adaptation of the MTs-402 chrominance module in television sets for both standards. Separate adaptation for each standard involves testing the module with full-color TV signals of color bands in the respective standard, using the same 75/0/75/0 format and a 1.8 V swing from crest of synchronizing voltage pulse to the white level in each standard. The test with SECAM signals is followed by tuning the high-frequency circuit and the identification circuit, after the zero-crossover point on the demodulation characteristics of the frequency detectors have been preset, whereupon the peak-to-peak amplitude of R-Y and B-Y chrominance signals in this standard is adjusted. The test with PAL signals is followed by tuning the subcarrier-frequency oscillator, whereupon the the peak-to-peak amplitude of R-Y and B-Y chrominance signals in this standard is adjusted. The last step of the adaptation procedure is matching the delay line, by regulating the B-Y signal levels in adjacent rows. The entire procedure requires a voltmeter and an oscilloscope. Because the latest MTs-402 module differs from existing MTs-2 and MTs-3 chrominance modules, an adapter is provided for connecting an MTs-402 module to any ZUS color television set. Figures 2.

## Foreign-Made and Soviet-Made Minimagnetophones

*927K0106D Moscow RADIO in Russian No 5, May 91 pp 49-54*

[Article by V. Shachnev]

[Abstract] A survey of tape minimagnetophones produced by foreign manufacturers (AIWA, Sony), some for playback only and some for both recording and playback, is followed by a survey of those which the Soviet industry has been building since the early nineteen eighties. Fourteen models of Soviet-made tape minimagnetophones ("Amfiton MS", "Diana-Stereo", "Duet-PM-8101", "Merkuriy M-302S", "Nerl P-411S", "Saturn MS", "Saturn P-401S", "Sokol-Mini", "Sonata P-421S", "Tom M-411S", "Elektronika Mikrokontsert Stereo", "Elektronika M-401S", "Elektronika 402S", "Elektronika M-332S") are described and compared with respect to performance characteristics (flutter coefficient, total effective frequency range, overall weighted signal-to-noise ratio), size, supply voltage, and availability of features (recording equipment, built-in microphone. built-in loudspeaker, external active automatic synchronization, telephones, automatic stop, rewind). They are all comparable with medium-cost foreign ones, but none of them includes a radio receiver. One reason is lack of an All-Union State Standard designed specifically for minimagnetophones. Another reason is unavailability of low-voltage integrated microcircuits for AM and FM radio frequency bands. Figures 7; tables 1.

## Digital Oscillograph Set

*927K0106E Moscow RADIO in Russian No 5, May 91 pp 54-57*

[Article by A. Nozdrachev]

[Abstract] This concluding Part 2 of an article on a digital oscillograph set (Part 1 in RADIO No 4, 1991) covers the basic hardware, the setup procedure, and the operation of this instrument, including adjustments to be made during setup and adjustments to be made for various modes of operation. Several improvements in the design are recommended: replacement of series 155 microcircuits with series 531 microcircuits will raise the maximum operating frequency of the record head transformer up to 20 MHz or even 30 MHz; replacement of the K1107PV1 microcircuit with a K1107PV2 8-digit analog-to-digital converter and thus increasing the number of microcircuits in the random-access memory will almost completely eliminate the need for output signal smoothing; use of K155RU7 microcircuits for the random-access memory will make it possible to prolong the "history" of a recorded signal fourfold. The instrument can record individual video frames but also individual lines. Maximizing the sweep frequency and the memory capacity will minimize the error of signal duration measurement and maximize the reliability of signal recording. The instrument includes a record head transformer, a read head transformer, and an address generator in addition to the random-access memory with triggers and synchronizers. Operation in the analog mode requires additionally an analog-to-digital converter and a Y-digital-to-analog converter. Operation in the digital mode requires additionally an X-digital-to-analog converter and a multiplexer. Figures 2; references 3.

## Experimental Investigation of Absorption in Water Vapor in λ=0.2 mm Relative Spectral Window

[Article by B.A. Sverdlov, N.I. Furashov, Scientific Research Radiophysics Institute; UDC 621.371.246:621.3.029.66]

[Abstract] An attempt is made to determine the effect of the absorption of H₂O molecules by duralumin reflectors on the results of special measurements of the attenuation factor of radiation at a λ=0.2 mm wavelength by the moist air surrounding the reflectors in order to determine the dependence of the water vapor absorptance on its concentration in the air and identify possible systematic errors in measurements of molecular absorption in water vapor related to the adsorption of H₂O molecules by the experimental unit elements; the measurements are taken by an echelette vacuum spectrometer with a DRT-220 mercury arc lamp as a radiation source and an OAP-7 pneumatic detector. The dependence of the water vapor's absorptance on its concentration in the air in the 0.2 mm spectral window is analyzed and the absorptance components which depend on the absolute air humidity by the linear and square law are identified separately. The experimental results of water vapor absorption measurements in the spectral window are compared to theoretical data. An optical attachment which makes it possible almost to double the number of radiation reflections in the spectrometer without substantially increasing the optical path length is used to measure the relative contribution of the water molecule adsorption by the reflectors to absorption. Based on the parameters obtained in the study and the theoretical dependence of absorption on temperature, a formula is derived for standard conditions: $\Gamma=286 +/- 3$ dB/km; it is consistent with the measurement results. The authors are grateful to I.A. Rakova for computer analyses. Tables 1; references 49: 21 Russian, 28 Western.

## Method of Radio Acoustic Sounding Using Amplitude-Modulated Radio Signal

[Article by A.L. Fabrikant, Applied Physics Institute at the USSR Academy of Sciences; UDC 551.501.724:551.596]

[Abstract] The efficacy of radio acoustic sounding (RAZ) of the atmosphere based on the backscattering of monochromatic radio signals by density perturbations in the train of a traveling sound wave is determined by the coherent composition of the radio signals reflected by various parts of the acoustic wave packet provided that Bragg's condition is met. A modification of the radio acoustic sounding method based on using microwave amplitude-modulated radio signals and long-wave sound is proposed. The method makes it possible to use the envelope of the modulated microwave radiation scattered by natural atmospheric inhomogeneities as the radio acoustic sounding wave; it is based on measuring the Doppler shift of the scattered radio signal modulation frequency appearing when the concentration of noncoherent scatterers, e.g., cloud drops, aerosol, etc., oscillates in the field of the traveling sound wave. By measuring the modulation frequency shift we can determine the speed of sound within the atmospheric volume under study. It is noted that the proposed method may be suitable for sounding not only the atmosphere but also other natural media and can be used in a lab. One can use amplitude modulation of laser radiation while simultaneously studying sound pulses in order to measure the temperature profile of the near-surface ocean layer. The depth accessible to such a sounding method is determined by the attenuation scale of laser radiation propagating into the ocean. The article is submitted on disc. References 7.

## Dynamic Characteristics of Signals Scattered by Artificial Ionospheric Turbulence

[Article by V.A. Gudin, V.N. Deyneko, V.N. Ivanov, Yu.A. Ignatyev, P.B. Shavin, Scientific Research Radiophysics Institute; UDC 621.371.25]

[Abstract] The parameters of the signals scattered by artificial ionospheric inhomogeneities appearing under the effect of high-power decameter RF radiation on the ionosphere are investigated in order to determine the principal characteristics of an artificial disturbance area in the upper ionosphere; the characteristics of backscattered signal (SOR) from the disturbance area were measured in 1987-1989 during the day and in the evening simultaneously over two oblique incidence backscatter paths of varying extent whereby the Sura test bench is used to create the artificial disturbance at a 4.785 MHz frequency with an equivalent power of 50-75 MW in cycles of 5 s to 5 min. The backscattered signal development during short ionospheric heating periods is examined and these signals' Doppler frequency fluctuations are studied. Attention is focused on the dynamics of the spectral characteristics of backscattered signals during short heating periods. New characteristics manifested by quasiperiodic changes on the Doppler backscattered signal frequency with 20-60 s periods and the presence of regular inhomogeneity motion toward the disturbance center at a 20-30 m/s rate are discovered; the times of the backscattered signal appearance after the start of ionospheric heating over 1,300 km and 110 km long paths differ little from each other and are equal to 1-2 and 1.5-4 s, respectively. The authors are grateful to Ye.A.

Benediktov and G.I. Grigoryev for constructive remarks and S.A. Dmitriyev for help with the experiments. References 12.

## Outcome of Experimental Investigations of Artificial Low-Frequency Amplitude Beats of Radio Waves Reflected by Ionosphere

[Article by G.N. Boyko, L.M. Yerukhimov, V.L. Frolov, Scientific Research Radiophysics Institute; UDC 550.388.2]

[Abstract] The interaction of high-power RF radiation with plasma in the ionosphere's F-area investigated experimentally in 1987-1989 using the Sura heating test bench in Nizhniy Novgorod is discussed and experiments employing the X-polarization of high-power radiation are described; these experiments demonstrate the presence of amplitude beats of the signals reflected by the ionosphere. The characteristics of quasiharmonic amplitude beats of the signals reflected by the ionosphere and the sounding waves (PV) at close to the pump wave (VN) frequency are investigated and their possible mechanism is discussed; it is speculated that the beats are formed due to an interaction of waves in the presence of a spatial periodic plasma density lattice formed in the standing wave field of high-power RF radiation. The experimental findings are compared to the above model. An analysis of the low-frequency amplitude beats of the pump wave and sounding wave signals with proximate detuning frequencies demonstrates the effect of the high-power radio wave structure near its reflection level on the development character of the pump wave interaction with plasma at the first time moment after the start of its impact. The authors are grateful to A.N. Karashtin for constructive discussions and to the staff of the Sura test unit for help with taking the measurements. Figures 2; tables 1; references 15: 10 Russian, 5 Western.

## Analysis of Stationary Characteristics of Adaptive Antenna Arrays in Presence of Legitimate Signal Wave Front Fluctuations

[Article by A.A. Maltsev, G.V. Serebryakov, Nizhniy Novgorod State University; UDC621.396.671.8]

[Abstract] The a priori requirements being imposed on the legitimate signals in adaptive antenna arrays (AAR) under stationary conditions and the errors appearing in the amplitude-phase distribution induced by the legitimate signal source in the array elements are discussed and the principal characteristics of adaptive antenna arrays in the presence of small distortions of the legitimate signal wave front varying in the domain of time are investigated. To this end, two extreme cases are analyzed—slow and fast fluctuations of the $\Delta S(t)$ vector relative to the adaptive algorithm adjustment time. The effect of the aperture dimensions and the legitimate signal fluctuations and power on the output signal/noise ratio is examined and the case of the angle of arrival fluctuations of the legitimate signal is considered. One can see that an increase in the number of antenna array elements leads to a more significant decrease in the output signal/noise ratio (OSSh). The article is submitted on disc. Figures 2; references 8: 6 Russian, 2 Western.

## Modulation Instability in Optical Fiber Induced by Cross-Phase Modulation

[Article by N.N. Akhmedov, V.I. Korneyev, N.V. Mitskevich, Scientific Research Radiophysics Institute; UDC 538.56]

[Abstract] The modulation instability phenomenon in nonlinear disperse media, e.g., optical fibers, which leads to a decay of continuous weakly modulated radiation into a periodic sequence of ultrashort pulses is discussed and a new type of modulation instability is investigated by numerical methods without limiting ourselves to the linear approximation of the perturbation theory. General patterns of modulation instability are examined and phase trajectories of the solutions are analyzed so as to establish the cases in which the Fermi-Past-Ulam return phenomenon characteristic of the separatrix solutions of Schroedinger's nonlinear equation (NUSh) occur and those in which there is no such return. The numerical study of the new type of instability induced by a nonlinear interaction of two fields demonstrates that at the same field amplitudes, the return to the initial continuous wave state is accompanied by an additional phase shift while in the case of differing amplitude there is no recurrence to the initial state. The study is performed in a birefringent quartz fiber. Figures 3; references 11: 6 Russian, 5 Western.

## Effect of Sea Roughness on Structure of Satellite Microwave Radio Signals

[Article by A.V. Volkov, S.N. Krivonozhkin, L.A. Slavutskiy, B.N. Shevtsov, Pacific Oceanology Institute at the Far Eastern Department of the USSR Academy of Sciences; UDC 538.56]

[Abstract] The disappearance of the interference minima in microwave remote sensing of the ocean surface from space at small incidence angles prompted a study of the effect of the sea surface state on the structure of microwave probing signals. To this end, monochromatic circularly polarized signals radiated by satellites of the Tranzit navigation system are used in controlled experiments while measurements of the thermal RF radiation of the sea surface are taken on a 1.35 cm wavelength in order to monitor the state of the sea surface. The pitching and rolling contribution is estimated with the help of a gyro transducer and filtered out by spectral processing. The experimental dependence of the satellite radio signal amplitude on the satellite elevation angle for the 150 MHz probing signal frequency is plotted and a formula of the dependence of the sea surface reflectance on the angle of elevation is derived. The study shows that large-scale surface waves may substantially distort the interference pattern of microwave signals. Scientists from the Atmospheric Physics Institute and Leningrad Polytechnic Institute assisted in the experiments. The authors are grateful to B.S. Agrovskiy, A.N. Bogaturov, S.S. Kashkarov, A.S. Smirnov, O.B. Utrobin, and D.V. Shannikov. Figures 2; references 4: 3 Russian, 1 Western.

## Reconstructing Vertical Internal Tropospheric Wave Structure From Multifrequency Measurements in $O_2$ Line

[Article by K.P. Gaykovich, A.V. Troitskiy, Radiophysics Scientific Research Institute; UDC 551.575:551.543:551.521.9]

[Abstract] The sources of internal gravitational waves (VGV) in the boundary atmospheric layer are discussed and an expression for thermal RF emission of the atmosphere during the internal gravitational wave propagation is derived. The frequencies of the internal gravitational waves observed in the stratosphere are measured by spectral analysis of the atmosphere's thermal RF emission dynamics in the time domain at a frequency of 53.5, 54.0, 54.5, and 55.0 GHz in the $O_2$ spectral line. The effect of the internal gravitational wave frequency on the radiance temperature variability is assessed. Methods of reconstructing the altitude profile of the internal gravitational wave temperature disturbance from multispectral radiometry measurements are considered. An analysis of the reconstruction results confirms the possibility of multispectral radiometry measurements for detecting and determining the vertical structure and parameters of internal gravitational waves even in complex cases where the processes occur simultaneously within several altitude intervals. Tables 1; references 7: 6 Russian, 1 Western.

## Experimental Investigation of Active Open Optical Resonator in Turbulent Atmosphere

[Article by S.S. Mikhaylovskiy, P.N. Gusak, L.S. Nenov, Odessa Hydrometeorological Institute; UDC 538.56:519.25]

[Abstract] Stochastic boundary value problems of electromagnetic wave propagation in a multimode waveguide with a laminar-nonuniform refractive index whose stochastic fluctuations have finite correlations and the transport processes are described in the framework of a mode notation and are characterized by the random mode amplitude and eigenvalue statistics are discussed; one of many possible models of a stochastic waveguide system realized as an open Fabry-Perot resonator placed in an air flow with a developed refractive index turbulence is examined experimentally. To this end, spectral densities (SP) of the amplitude fluctuations of steady-state generation in the domain of time at two wavelengths of 0.63 and 1.15 μm are examined in such a system. The frequency dependence of spectral density is analyzed at various atmospheric turbulence states, including a wind tunnel. It is shown that the water vapor concentration fluctuations form a random absorption field. The conclusion is drawn that the principle of self-similarity of the statistical parameters of the wave field and characteristics of random refractive index fluctuations is realized in an open optical resonator. Estimates of the frequency dependence of spectral density in the high-frequency spectral region may be used for analyzing the properties of random refractive index fields, e.g., the fractal structure of turbulent eddies. Thus, an active open laser resonator tuned to the absorption frequency of the medium components may be used for studying turbulent diffusion of a passive impurity. Figures 4; references 13.

## Nonstationary Thermal Self-Action of Partially Coherent Laser Radiation

[Article by V.A. Aleshkevich, G.D. Kozhoridze, A.N. Matveyev, M.V. Shamonin, Moscow State University; UDC 621.373.826]

[Abstract] The issue of thermal self-action of pulses which are partially coherent in the domains of space and time is addressed and nonstationary thermal self-action of partially coherent laser radiation is examined analytically by the nonlinear phase channel method. A formula is derived for the nonlinear refractive index perturbation of the medium due to the laser field distortions in the transverse beam cross section and in the pulse duration

domain as a result of the nonuniform heating caused by the light absorption during the laser radiation propagation in a nonlinear gaseous or liquid medium. In analyzing the resulting formulas, emphasis is placed on establishing the mechanism of the principal effects of the noncoherent nonstationary thermal self-action condition. The nonmonotonic change in the correlation radius with the pulse duration is recorded and attributed to a competition of diffraction and nonlinear coherent and noncoherent effects. A good consistency of the findings with the results of laboratory and numerical experiments is noted. References 9.

## Optoelectronic Two-Beam Gyrotron Systems

[Article by V.Ye. Zapevalov, V.N. Manuylov, Sh.Ye. Tsimring, Applied Physics Institute at the USSR Academy of Sciences; UDC 621.385.69]

[Abstract] The negative effect of the gyrotron interaction space cross section dimension on the mode selection and the effect of the introduction of several coaxial screw electron beams (VEP) on the single-mode generation stability are discussed and principal design versions of the simplest two-beam gyrotron systems developed on the basis of magnetron injection guns (MIP) are considered. The constraints imposed on the system configuration by the adiabatic theory of magnetron injection guns are estimated and the beam trajectory of two-beam systems is analyzed; the analysis confirms the possibility of attaining satisfactory parameters of both the absorbing and emitting beam. The development of the gyrotron's optoelectronic system (EOS) is facilitated when the characteristic scale of emitting beam's electron trajectories are substantially smaller than the gaps between the electrodes; otherwise, the electrode configuration correction may be insufficient for attaining acceptable pitch factor values of both beams. Thus, systems with a uniform magnetic field in the gun area have a certain advantages although they are more sensitive to the current passage; consequently, the use of bipotential anodes is recommended. Figures 4; references 9: 8 Russian, 1 Western.

## About One Radar Method of Large Drop Detection in Clouds

[Article by V.Ye. Dudin, Radiophysics Scientific Research Institute; UDC 621.371]

[Abstract] A method of large cloud drop indication based on examining the statistical properties of the echo signal of a pulse Doppler radar is elaborated. In so doing, it is assumed that the echo signal is random and represents a sum of signals whose power depends both on the effective scattering cross section (EPR) of individual scatterers and on the number of cloud scatterers with the radar pulse volume. From the phase discriminator output of the pulse Doppler radar, the echo signal enters the input of a spectral analyzer which is a set of filters. The probability density as a function of the number of scatterers is derived and the results of its numerical calculation for various numbers of scatterers are presented. The conclusion is drawn that probability density discrimination is possible even for a small number of scatterers; if the number is less than 10, the sample size should be equal to approximately 100. Experimental probability density distributions are plotted for the rain and for clouds without drops. An analysis of the experiments conducted on a 35 cm wavelength in a Nalchik testing range confirms the possibility of using the method to determine the presence of large drops in clouds. Figures 2; references 5: 3 Russian; 2 Western.

## On *E*-Region Variation Mechanism During Geomagnetic Disturbances

[Article by L.A. Antonova, G.S. Ivanov-Kholodnyy, V.Ye. Chertoprud, Applied Geophysics Institute at the USSR State Committee on Hydrometeorology and Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation Institute at the USSR Academy of Sciences; UDC 523.98:550.386:550.388.2]

[Abstract] The ionosphere's *E*-layer response to geomagnetic disturbances and the likely mechanisms of the *E*-layer variations under geomagnetic disturbances are addressed and the decrease in the electron concentration around noon at the layer's peak is discussed. The mechanism of the $n_e E$ decrease after geomagnetic disturbances and the effect of saturation during severe magnetic storms are examined in detail. It is shown that allowing for the changes in the atmosphere's density at an altitude of about 100 km, the electron concentration decrease can be attributed to a decrease in the critical frequency; the decrease in the magnitude of the effect during severe magnetic storms can be attributed to the additional ionization in the *E*-layer due to an influx of electrons with an energy of several hundred kiloelectronvolts pouring into the atmosphere. References 10: 6 Russian, 4 Western.

## Diagnostics of Plasma Oscillation Excitation by High-Power Radio Wave Field

[Article by I.V. Berezin, V.B. Belyanskiy, N.I. Budko, V.V. Vaskov, Ya.S. Dimant, V.A. Zyuzin, O.P. Kapustina, G.P. Komrakov, G.A. Mikhaylova, V.A.

Panchenko, A.V. Prokofyev, V.A. Ryzhov, Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation Institute at the USSR Academy of Sciences and the Radiophysical Scientific Research Institute; UDC 550.388.2]

[Abstract] Experimental multifrequency diagnostics of the plasma oscillation excitation within the entire plasma resonance band with simultaneous recording of the resulting disturbances' time response conducted in a "Sura" unit in 1987-1989 during the evening hours or after dark when a powerful radio wave was reflected at sufficiently high altitudes of $\geq 250$ km is reported. Local plasma displacement in the upper hybrid resonance region (VGR) and in the vicinity of the level of powerful radio wave reflection from the ionosphere is recorded by multifrequency Doppler probing. The phenomenon indicates that high-frequency plasma turbulence is locally excited in these ionospheric regions; in the VGR region, plasma disturbances are considerably greater in magnitude and spatial dimensions than in the other region and begin to develop with a certain lag behind the excitation at the reflection point. The results are consistent with the model of two-stage plasma turbulence excitation by the powerful wave—consisting of a fast striction phase and a slow thermal phase—as a result of the development of strictive plasma instability and the thermal irregularities elongated along the magnetic field. Figures 4; references 12: 9 Russian, 3 Western.

## Measuring Radiation Dose at 'Mir' Station During Solar Proton Events in Sep-Oct 89

[Article by L.V. Tverskaya, M.V. Teltsov, V.I. Shumshurov, Nuclear Physics Scientific Research Institute at the Moscow State University; UDC 524.1:523.9]

[Abstract] The outcome of an investigation of the radiation dose variations measured inside the Mir orbital station during the period of increasing solar cosmic ray activity in Sep-Oct 89 when the station was in orbit with a 410 km apogee, a 380 km perigee, and a 51.6° inclination is reported. It is shown that dangerous dose increases correlate with the periods when the space vehicle approached the Earth during severe magnetic disturbances of the solar proton penetration boundary. The duration of the space station stay in the polar solar proton intensity plateau is analyzed allowing for model proton penetration boundary calculations and recent experimental data. The radiation timing chart is plotted. The study illustrates the considerable discrepancy of the experimental results and model calculations. A sharp 2 rad increase in the radiation dose which lasted for 4 h poses a serious radiation hazard for the crew, especially during the extravehicular activity. The need to develop extreme situation models of the magnetosphere on the basis of the most recent scientific findings is emphasized. Figures 1; references 6: 3 Russian, 3 Western.

## Experimental Investigation of Coherent Snow Echo Signal Spectra in 140 GHz Band

[Article by V.S. Korostelev, G.I. Khlopov, V.P. Shestopalov, Radiophysics and Electronics Institute at the Ukrainian Academy of Sciences; UDC 621.396.96]

[Abstract] The importance of knowing signal propagation in precipitation for communication, navigation, and radar systems is noted and early results of experimental studies of the energy fluctuation of coherent echo signals from snow in the 140 GHz conducted during the winter of 1988 over the European part of the USSR with the help of a coherent instrumentation radar (RLS) on the basis of a diffraction radiation generator (GDI) in the CW mode at a mean 0.5 W power, a spectral receiver response of 5 x $10^{-18}$ W/Hz, and a noise factor of 21 dB are reported. A method of measuring the equivalent scattering cross section of the snow flakes—spatially distributed reflectors—with the help of a bistatic coherent radar with intersecting beams is proposed and the characteristic energy spectra and their parameters, i.e., the effective bandwidth and spectral density maximum of the equivalent scattering cross section, are cited. The echo signal calibration characteristics are described. Data are processed on a BESM-6 computer. It is noted that the energy bandwidth at the shorter wave end of the millimeter band greatly exceeds the adjusted intensity bandwidth at the longer wave end, probably due to the phase modulation characteristics of coherent signals scattered by a set of random reflectors moving in the wind pattern. Figures 4; tables 1; references 14: 11 Russian, 3 Western.

## Shortwave Band Atmospheric Radio Acoustic Probing System

[Article by V.A. Zinichev, V.O. Rapoport, V.Yu. Trakhtengerts, A.L. Fabrikant, Yu.G. Fedoseyev, Applied Physics Institute at the USSR Academy of Sciences; UDC 551:501]

[Abstract] Range and altitude limitations of existing radio acoustic atmospheric and tropospheric probing systems (RAZ) are discussed and a working prototype of a radio acoustic probing system operating in the shortwave (KV) band which makes it possible to check system capabilities in the meter wave band as well as adjust the necessary software is described. Given favorable wind conditions, such as an absence of wind and stable stratification, and sufficiently low noise levels (from broadcast and communication stations), the unit has a 4-5 km operating range. Since the wind drift was not

compensated for in the experiment, the probing altitude decreased significantly even in the presence of a moderate wind. The unit is executed on the basis of a bistatic design and operates in the 19 MHz band at a 40-42.5 Hz probing sound pulse frequency. The method of processing the RF echo signal reflected by the acoustic wave is considered and various factors affecting the temperature profile measurement accuracy are discussed. The authors are grateful to V.I. Balabanov for active participation in the effort. Figures 2; references 7.

### Radiophysical Aspects of Thermal Stratospheric Sensing From Satellites in $O_2$ Absorption Lines in 55-65 GHz Frequency Band

[Article by A.A. Vlasov, Ye.N. Kadygrov, A.N. Shaposhnikov, Central Aerological Observatory; UDC 551.501.8]

[Abstract] The importance of on-line measurements of the stratosphere's temperature on a global scale for environmental research and particularly for monitoring the Earth's ozone layer is emphasized and methods of increasing the accuracy and altitude of thermal remote sensing of the stratosphere from satellites (ISZ) in the millimeter band are considered. The weight factors of a six-spectra microwave (SVCh) radiometer are calculated as a function of the absorption variations with frequency within each bandwidth. In order to check the theoretical calculations experimentally, $O_2$ absorptance was measured by a spectrometer. To check the satellite radiometer parameter selection, it was tested on a balloon; the balloon experiment confirmed the possibility of taking remote stratospheric temperature measurements by a microwave radiometer. An analysis of the theoretical and experimental results shows that in order to increase the thermal remote sensing altitude to 50 km, the microwave radiometer must be capable of measuring radiation within narrow bands at close-to-resonance frequencies. Figures 3; tables 4; references 23:15 Russian, 8 Western.

### Synthesizing Optimum Radiometer With Input Signal Frequency Filtering

[Article by V.I. Antofeyev, A.S. Sultanov; UDC 535.8:535.214.4]

[Abstract] The problem of synthesizing an optimum radiometer is solved in the frequency domain using the methods of the signal parameter estimation theory; in so doing, modulation is considered as an operation of "coloring" the legitimate and standard signals necessary for discriminating the signals against the background of "white" receiver noise. The radiometer is optimal from the viewpoint of the *a posterior* probability maximum in the presence of Gaussian RF section gain fluctuations. Under certain conditions, the synthesized radiometer has the same properties as an optimum modulation radiometer but instead of the modulator on its input, it has a filter with a nonuniform amplitude-frequency response within the transmission band. A block diagram of the radiometer is cited. The findings make it possible to develop a new radiometer which according to its operating principle, is referred to as a compensated-filtered radiometer (KFR). It is noted that the approach used for synthesizing the optimum filtered-input radiometer may also be considered from the frequency-time duality theory viewpoint. Figures 2; references 6.

## Potential Accuracy Estimates of Digital Signal Processing Algorithms in the Presence of External Noise

[Article by I. K. Daugabet and A. A. Lanne; UDC
621.391.26.003.12]

[Abstract] This article examines issues associated with
the synthesis of digital signal processing algorithms using
input and output when there is external noise affecting
the input signals. The transformation of input signals
into output signals is modeled. The maximum possible
accuracy of the representation of this transformation is
determined when there is noise of a given intensity. An
engineering method is developed to numerically esti-
mate the maximum possible accuracy in representing
specific digital signal processing operators. A survey of
results in the field, analytical and numerical estimates of
algorithm accuracy, and practical examples of theory
application are presented. The examples include a har-
monic oscillations amplitude detector, an amplitude
detector which transforms harmonic signals, an attenu-
ating amplitude signal detector, a frequency detector,
and a phase detector. Figures 4; table 1; references 7: 6
Russian 1 Western.

## Frequency-Time Distribution of Signal Strength in Walsh Basis Functions

[Article by A. A. Alekseyev, A. B. Kirillov and S. Yu.
Chechenev; UDC 621.391.246:519.224]

[Abstract] Digital signal processing can make effective
use of fast Fourier transform procedures, and when one
moves to another class of spectral transforms which
better meets the needs of digital signal processing, one
can further increase analysis speed. The goal of this
article is to generalize the frequency-time distribution to
a basis Walsh function. This article introduces the con-
cept of the combined frequency-time distribution of
signal strength in basic Walsh functions, and is based on
"subtraction by module two." Basic properties of the
distribution are analyzed. The basic conditions for
applying this concept in the analysis of radio signal
structure are defined. The results of experimental com-
puter studies are presented, and these results confirm the
expediency of using this concept in the analysis of the
frequency-time distribution. A Wigner pseudodistribu-
tion of a frequency-manipulated signal calculated in a
discrete exponential function basis is compared with the
same in a Walsh basis. The experimental results confirm
that it is possible to use a Walsh distribution to evaluate
the frequency-time structure of processes. The Wigner
pseudodistribution in a Walsh basis simplifies as much
as possible the procedure of discretization of an analog
signal when there is no analog-to-digital converter. The
structure of the analyzer and the structure of the signal
reduces digital signal processing to the transformation of
a binary stream of information. Finally the Wigner
pseudodistribution in a Walsh basis is better suited to
the organization of computing on any type of computer
because the most complex operation in the algorithm is
arithmetic addition of whole numbers. The processing
speed is increased by an order of magnitude. This
method is also shown to be preferable to the use of an
instantaneous Walsh spectrum. Figures 5; table 1; refer-
ences 4: 3 Russian 1 Western.

## Theoretical Number Mersenne Transforms for Fast Computation of Convolutions of Real Data With Their Lengths Factorized by Powers of Two

[Article by Yu. I. Gagarin and K. Yu. Gagarin; UDC
621.391.254.004.68]

[Abstract] This article examines a new class of theoret-
ical number Mersenne transforms in basic fields with
lengths factorized by powers of two. "Fast" algorithms
are presented for one- and two-dimensional transforms.
These algorithms are oriented toward calculation
without scaling error and rounding of real convolutions
of great length. Pseudo-nested algorithms for two-
dimensional theoretical number Mersenne transforms
are constructed from one-dimensional fast transforms in
base 2. Practical implementation of these fast theoretical
number Mersenne transforms in the arithmetic of
inverse codes is much simpler and faster than the imple-
mentaiton of "fast" convolutional algorithms in floating-
point artihmetic in a field of real numbers if the calcu-
lation error is taken to be the same. The use of
theoretical number Mersenne transforms significantly
increases the accuracy of fast calculation of cyclical
correlations and convolutions. A set of programs has
been developed for the design of signal processors based
on theoretical number transforms. Figures 4; table 1;
references 7 (Russian).

## Spectral Pairs in Linear Prediction

[Article by V. I. Vorobyev, V. N. Ivanov, and D. A.
Ulakhovich; UDC 621.372.54.037.372.001.15]

[Abstract] The method of linear prediction is used in
digital processing for frame-by-frame (time interval)
adaptive filtering of a stochastic signal. Linear spectral

pairs are one way of representing information on the spectrum of the part of the signal contained in the studied time segment. They are convenient for coding a dynamic range, and they provide stability to the inverse filter, even when the pairs are quantized. Based on theorems on the transformation of a minimal-phase polynomial, one possible algorithm for obtaining linear spectral pairs is presented. Its implementation on a TMS32010 signal processor is examined. The problem of coding transmitted parameters is solved with an optimal scalar Lloyd-Max quantization to provide a signal to noise ratio of 22 or 33 dB. Figures 4; tables 2; references 6: 4 Russian 2 Western.

## Digital Filter Design and Analysis Program Package for the IBM PC

[Article by A. A. Lanne, Ye. K. Tavastsherna, A. O. Talanov, D. A. Ulakhovich, and P. V. Yakovlev; UDC 621.372.54.037.372.001.24]

[Abstract] This article presents a new program package, FD-1 (Filter Design-1) intended to calculate optimal transfer functions for a broad class of digital filters and to analyze their frequency and time characteristics. The package includes a program to calculate the transfer functions of digital filters, a program to analyze the frequency and time characteristics of digital filters, and an interface shell which contains a graphics editor to assign amplitude-frequency characteristic requirements. The transfer function program makes it possible to examine the coefficients of Chebyshev optimal nonrecursive filters with a linear phase-frequency characteristic and an arbitrary amplitude-frequency characteristic. One can design corrector filters, multiband filters, differentiators, and integrators. The program also calculates the transfer functions of recursive filters with an arbitrary amplitude-frequency characteristic. All calculations are done in double precision. The program for analysis of the frequency and time characteristic of filters obtains a pulse characteristic and a map of the zeroes and plusses of the transfer function, displays the filter coefficients and the transfer function of recursive elements, presents the structure of the recursive filter element by element in a separate window, and recalculates the design for a filter whose characteristics are read from a file or from the keyboard. Changes can be made with a mouse or keyboard. There is a help system, and the program builds a library of results. The closest similar program is DFDP version 1.11. The advantages of FD-1 over DFDP are presented in a table. Table 1; references 5: 2 Russian, 3 Western.

## Synthesis of Two-Dimensional Nonrecursive Digital Filters by the Energy Balance Criterion

[Article by V. A. Suchilin; UDC 621.372.542:621.301]

[Abstract] This article generalizes a method of synthesizing a class of one-dimensional nonrecursive digital filters to a two-dimensional class. The energy balance criterion is used. Features of the implemenation of this method are examined. This approach is clearly the best in the sense of the synthesis criterion which is used. Data is presented so that the synthesis results of this method can be compared with methods using other criteria. Figures 2; references 5 (Russian).

## Application of Weighting Windows To Suppress Harmonic Noise in Digital Processing of Complex Signals With Discrete Frequency Manipulation

[Article by V. A. Vargauzin; UDC 621.391.825. 621.396.669]

[Abstract] This article examines an ensemble of complex signals with discrete frequency manipulation for the case of orthogonal signals. It is assumed that signals are received on a background of Gaussian white noise and harmonic noise. The receiving algorithm is optimal only when this type of noise is present. The case of typical frequency manipulation with pseudorandom retuning of the working frequency to one frequency of a frequency grid is used. The noise resistance of signal reception in the presence of harmonic noise depends significantly on the noise frequency. The probability of reception error is evaluated. It is possible to reduce the level of the side lobes of the spectrum of harmonic noise using weighting windows. However, a weighting window and the positive effect of harmonic noise suppression leads to a reduction of the energy of the useful signal. Thus, it is interesting to analyze the effectiveness and expediency of using a weighting window in the implementation of a discrimination algorithm. It is found that the use of a window is very effective when noise is strong. The Hemming window and the triangular Barlett window were modeled and found to be equivalent in terms of the probability of erroneous reception. The Blackman-Harris and Kaiser-Bessel windows were found to be less effective. References 5 (Russian).

## Spectral Analysis of the Autoregressive Moving Average Process by the Minimax Entropy Method

[Article by G. V. Yermakova; UDC 621.391:519.272]

[Abstract] Autoregressive moving average processes are widely used in the spectral analysis of random processes. Among the critical problems involved is the problem of small observation samples. One effective method of solving this problem is paralleling of the processing in accordance with the variation principle of the minimax entropy method. This article presents a new modification of the minimax entropy method applied to the spectral analysis of autoregressive moving average processes. The basic idea of the minimax entropy principle is the use of current information on the frequency characteristics of a set of parallel decorrelators in the spectral evaluation. Each is adapted as the process is observed in a finite interval of analysis. A different implementation of the principle uses different sets of decorrelators. In the analysis of an autoregressive moving average process, one must have autoregressive and moving average components of the process. The method of obtaining decorrelators is described. Analysis of the results shows that this method provides a stable gain in accuracy, which is especially significant when there are small samples. The method also has a good convergence rate. Figures 4; references 4 (Russian).

## Loading of the Digital Signal Processing System at the Acousto-Optic Fourier Processor Output

[Article by G. V. Pevtsov and V. I. Kostetskiy; UDC 621.317:681.142]

[Abstract] Acousto-optic Fourier processors are used to create wideband one-channel analog-digital panoramic receivers and spectral analyzers. A main quality indicator for this type of device is the load on the special processor. This article develops a method of determining the load on the digital multiprocessor system for signal processing at the output of an acousto-optic Fourier processor. Examples of three typical structures of a digital multiprocessor signal processing system are given: a sequential system in single-program mode, a sequential system in multi-program mode, and a parallel system in multi-program dynamic mode. The average service time is determined. References 3 (Russian).

## New Quantization Method of Linear Spectral Frequencies

[Article by Ye. P. Ponomarev and V. I. Dudin; UDC 621.396.21]

[Abstract] One way of digitally representing the parameters of a linear prediction is their transformation into linear spectral frequencies with subsequent quantization of the latter. The main problem with this is the preservation of the ratio of orders in the set of quantized values, as a disruption here leads to instability in the model of linear prediction. One way of overcoming this problem is the use of differential methods of quantization. But this is recommended only when the effect of errors on the digital representation of parameters is completely eliminated, since differential quantization leads to an accumulation of errors and substantial distortion of the parameters of the linear predictor. Thus, it is expedient to use methods of independent quantization for each spectral frequency so that errors in one does not lead to a change in the values of others. This article outlines an algorithm for the quantization of linear spectral frequencies which provides independent digital representation of each of them with the same accuracy as the method of full dynamic programming (independent quantization) with a complexity similar to the procedure of typical quantization of parameters. The suboptimal algorithm for quantization of linear spectral frequencies presented here coincides in accuracy of quantization with the optimal algorithm and is less complex in terms of computation. Reference 1 (Western).

## Rating of Mobile Radio Communication Systems With an Emitting Cable for Structures With a Complex Configuration

[Article by V. I. Vostroilov; UDC 621.396.2]

[Abstract] Equations are obtained for mobile radio communication systems with an emitting cable and retranslators. These equations make it possible to verify the power of the communication lines and determine the basic parameters of elements of the communication system. Equations are also derived for the receiving and transmitting tracks of the system's base station. These equations can be used to determine optimal parameters of elements of the radio communication system if one considers the operating conditions, configuration of the structure (tunnel, shaft, building, etc.), and the requirements made on the equipment. The transmission coefficient is chosen to be optimal (from the point of view of minimization of noise in the cable lines). Losses in the

lines are calculated, and the maximum distance of communication is established. Figure 1; references 3: 1 Russian 2 Western.

## Determination of the Bandwidth of an Underground Radio Line With an FM Signal

[Article by V. N. Nikolayenko, V. A. Rabotkin, E. N. Soshnikov, and V. T. Tolcheyev; UDC 621.391.8]

[Abstract] In underground lines the bandwidth is limited by signal distortion and the multi-beam propagation of radio waves. Preliminary estimates are obtained for the maximum bandwidth of an underground radio line for communication over short distances (1-5 km). The estimates are determined from a considertaion of distortions of the correlation function of the FM signal for frequencies of 0.5-2 kHz. Figure 1; table 1; references 2 (Russian).

## Optimal Complex Signal Receiver Using a Kalman Filter

[Article by V. M. Sovetov; UDC 621.391.26]

[Abstract] This article presents a way of representing complex signals in the form of the output of a linear dynamic model in a Euclidean state space. An optimal receiver for complex signals is synthesized using a Kalman filter. Its noise resistance is analyzed. This optimized receiver is more generalized than other receivers in that it imposes no limits, that is, assumptions that the transmission coefficient remains constant over time, that there is no signal distortion, and that the signal strength and noise dispersion are constant over the period of observation. The parameters of the medium may be varied over the length of the complex signal. The Kalman filter considers not only changes in signal amplification but also more complex linear distortions. The recurrent algorithm for signal processing which is developed may be the basis for the synthesis of various adaptive algorithms for the processing of complex signals and identification of the parameters of a dynamic model in a state space. Figures 4; references 5 (Russian).

## Phasing of a Multi-Element Antenna System Using a Control Signal from a Satellite

[Article by A. V. Khevrolin; UDC 621.396.677]

[Abstract] This letter describes an article deposited at the Informsvyaz Center for Scientific and Technical Information. The advantages of phased antenna systems over individual antennas are discussed. Such systems have a large effective area and are inexpensive. Phasing compensates for atmospheric inhomogeneities which decrease the amplification of the antenna. The article studies the possibility of using a phased antenna system to receive signals from deep space. The use of a control signal not only compensates for atmospheric inhomogeneities but also compensates for instabilities in the antenna-feeder track. The article also discusses optimization of location, minimization of cost, and specific operational issues.

## Space-Time CCD Filter

[Article by A. V. Bogoslovskiy; UDC 621.37:621.383.8]

[Abstract] CCDs are usually used to process stationary images, but sometimes it is necessary to process moving images. This article describes a CCD operating mode which makes it possible to construct a discrete analog space-time filter to process moving images and determine their basic characteristics. Equations are derived to describe charge collection and directed transfer in this mode. Possible amplitude-frequency characteristics are analyzed. The filter can be effectively used in machine vision systems as well as for automatic measurement of the parameters of narrowband space-time fields. When it forms the video signal of the image of moving objects, the filter effectively suppresses the video signal of the image of objects moving in the opposite direction. The use of such filters makes it possible to simplify the subsequent task of image analysis. Figures 4; references 6 (Russian).

## Use of Computing Equipment To Conduct Communication Conferences

[Article by V. I. Korzhik]

[Abstract] This article addresses the use of computers to supplement reports at communication conferences by presenting demonstrations of results on displays or printers. The author discusses when a computer demonstration adds to a presentation and when it detracts from it, that is, "explaining the obscure with something even more obscure." Computers are effectively used to prove that algorithms work, in particular, iterative algorithms. Computers are also effectively used to present special examples using formulas which have been deduced, to present graphs and tables, and to enhance reports on the control of processes and systems, modeling of random signals and noise, and the processing of a limited statistical sample. They may also be used to advertise CAD systems, and to aid in creative thinking through visualization of problems and possible solutions. References 1 (Russian).

## Effect of Frequency Indeterminacy on a Convolver Search for Complex Signals

[Article by A. V. Kuzichkin, V. G. Lopatin, P. G. Tereshchenko, and A. G. Shadrin; UDC 621.391.26]

[Abstract] This article studies the effect of frequency indeterminacy of a complex signal on the acousto-electronic convolver signal search equipment. Expressions are obtained to calculate the probability and time characteristics of the search for complex signals using convolver equipment in the general case of a search by frequency and delay. The effect of frequency indeterminacy on optimal parameters in ideal and real convolver search equipment is evaluated. Once the problem of parametric optimization of the convolver equipment and the search procedure is solved, recommendations are developed which make it possible to minimize the adverse effect on the quality of operation of convolver equipment due to the effect of frequency indeterminacy of the received complex signal and a nonideal processing device. In order to guarantee the estimates of the length of the signal search procedure, reception and signal detection are assumed to occur under the worst possible conditions. There is a discussion of the effect of various parameters on search length when the parameters are not optimized. Figures 4; references 7 (Russian).

## Special Adaptation Processor as an Element of a Digital Radio Receiver

[Article by V. V. Balabanov and A. V. Chebotov; UDC 621.396.62]

[Abstract] This article examines an adaptation algorithm for the main receiving track of a signal and noise condition which is optimized for a set of criteria and which is implemented in a special processor. The algorithm assumes insufficient *a priori* knowledge about the signal and noise situation and provides a rigorous correspondence of the transmission coefficient of the main receiving tracks of the digital radio receiver in the decameter range to the level of the received signal. The adaptation algorithm can be implemented as an adaptation special processor using two 1804VC1 processor sections and a 556RT5 ROM. The program which implements the algorithm contains 512 commands. The command field occupies 2.5 kilobytes. The module can be used in digital radio receivers for the decameter or meter ranges. Figure 1; table 1; references 4 (Russian).

## Comprehensive System To Analyze Estimates of the Time Parameters of an Optical Signal

[Article by A. P. Trifonov, V. K. Buteyko and T. M. Ovhcinnikova; UDC 621.391.01]

[Abstract] Asymptotically exact formulas are obtained for the characteristics (for example, noise resistance) of estimates of the most likely arrival time and length of an optical signal. A method is proposed to substantially reduce the time needed to model these estimates using asymptotic formulas. At the same time this method permits one to monitor error and the area of application of asymptotic formulas. This type of monitoring is virtually unused in purely analytical methods. The time position and length of a square optical pulse is defined in the presence of noise. The modeling algorithm was implemented in a set of programs. They were written in PASCAL for implementation on an IBM personal computer. The convenient interface displays the process and results of analysis on the screen in graphic form. Figures 3; references 11: 10 Russian 1 Western.

## Detection of Point Signals on a Background of Interfering Images

[Article by K. K. Vasilyev and V. V. Balabanov; UDC 621.391.2]

[Abstract] In remote sensing of Earth, one must detect a signal which is concentrated in one element of spatial resolution on a background of noise with a spatial correlation. To increase the effectiveness of observation, a number of systems are used in a number of frequency ranges. The purpose of this article is the synthesis and analysis of an algorithm for the detection of point signals from a set of observations for the case of a Gaussian approximation of an *a posteriori* distribution of a vector of random values of a random field in the region of the supposed signal. The results of observation are taken to be a set of data files obtained as a result of spatial quantization of the image. The determination of a probability density distribution is discussed. In the optimal algorithm the following operations are done on the observations: formation of an optimal prediction based on the data, compensation of interfering images by subtraction of the optimal prediction from the observations, and repeated weighting summation of the differences, considering the a posteriori covariations of prediction errors and additive noise. Figures 4; references 6 (Russian).

## Analysis of the Process of Element-By-Element Processing of a FKM Signal With an Acousto-Optic Spectral Analyzer

[Article by V. G. Serdyukov and A. V. Tsygankova; UDC 621.391.272]

[Abstract] This article mathematically models the processing of an FKM [Phase Code Modulation] signal with an acousto-optic spectral analyzer in which the size of the aperture is set so that no more than one phase transition enters at one time. It is shown that it is possible to use various types of demodulators for FKM signals, not only with binary, but also multi-phase manipulation. However, the practical implementation of various forms of acousto-optic phase demodulators is not examined here. Figures 4; references 4 (Russian).

## Theory of Laser Radiation Focusing Into Line

[Article by E.E. Gasanov; UDC 537.874.6.01]

[Abstract] It is shown that a known problem of laser radiation focusing with the help of a planar optical element in a nonparaxial approximation which is formulated in the language of the $A$-mapping can be reduced with the help of a Legendre transform to a problem of laser radiation focusing along a line in a paraxial approximation in the context described by the author in *Radiotekhnika i elektronika* Vol. 36 No. 10. After finding the solution of the transformed problem, the solution of the original problem can be represented in an explicit form. Certain properties of the $A$-mapping are examined and a procedure is proposed for determining the phase function. The synthesis problem is formulated and its solution is analyzed. Figures 2; references 3.

## Streams of Rectangular Pulses With 'Good' Autocovariance Function

[Article by F.V. Golik; UDC 621.391.14:621.396]

[Abstract] Streams of rectangular pulses which belong to the class of random pulse processes and the issue of synthesizing rectangular pulse streams with specified properties are discussed and a class of streams tentatively referred as geometric which have a "good" autocovariance function (AKF) is synthesized. The problem is formulated as synthesizing streams whose autocovariance functions $r()$ decrease monotonically and in a particular case differ from 0 over a finite interval $\tau_0$ under the following constraints: the streams' mark and space durations are independent in totality; mathematical expectations of the mark and space durations are finite; and the pulse amplitude is fixed and equal to unity. A class of streams which are a modification of the synthesized geometric streams whose autocovariance functions have a form of damped oscillations is identified; the modified streams can approximate the geometric streams in their physical realization. The findings may be used for solving the problem of optimizing the procedure of stochastic time division multiplexing in asynchronous data transmission systems; furthermore, synthesized streams may be used in radio engineering systems with tunable parameters. References 5.

## Highest Values of Noise Signal on TWT Amplifier Output

[Article by G.M. Vorontsov; UDC 621.373.1]

[Abstract] The interaction of the electron current with multifrequency signals and signals with a continuous spectrum, e.g., microwave (SVCh) noise, in traveling wave tubes (LBV) and the conditions under which a wide-band noise signal interacting with the electron current exceeds the amplitude level of the RF oscillations in the monochromatic operation are discussed; the issue of the possibility of this phenomenon in the case of narrow-band noise is investigated. It is demonstrated experimentally that during the noise signal amplification in an O-type traveling wave tube (LBVO), noise spikes may greatly exceed the maximum RF oscillation amplitude but do not exceed this level in magnetron-type traveling wave tubes. The root-mean-square and maximum values of the noise signal with positive and negative polarity on the output of the O-type and M-type traveling wave tube amplifier as a function of the noise signal level on the input with 0.4 and 25 percent noise band on the input are plotted. The integral noise signal power on the output of a nonlinear M-type traveling wave tube amplifier is estimated. The author is grateful to N.N. Zalogin for discussing the findings. Figures 2; references 4: 3 Russian, 1 Western.

## Efficiency of Relativistic O-type Devices Allowing for Electron Interaction Energy

[Article by A.A. Kurayev, N.A. Kurayev, A.K. Sinitsyn; UDC 621.373.6.01]

[Abstract] The effect of the space charge forces or electron interaction forces on the processes of bunching and energy transfer on O-type devices and the lack of a strict theory of charged highly and ultrarelativistic particles' interaction during their nonuniform accelerated motion

are discussed. It is demonstrated by solving model problems that the interaction of rectilinear relativistic electron currents (REP) with electromagnetic fields has a significant effect on the bunching processes in the follow wave drift and acceleration area in O-type traveling wave tubes. The relativistic current electron motion equation is derived on the basis of the large particle method whereby the electron current is simulated by a set of moving large charged particles which are at first uniformly positioned over the period of the slow wave frequency. It is shown that the energy accumulation of the particle interaction in relativistic electron currents leads to an efficiency "defect" of O-type relativistic devices: efficiency losses reach significant levels if it is possible to bunch the high-current relativistic flux considerably. The conclusion is drawn that the electron interaction energy naturally limits these devices' efficiency and that correction of the space charge forces related to the particle acceleration does not significantly affect devices with distributed interaction where these accelerations are limited. Figures 2; references 3.

## Improving Time Response of Streak Tube Using Spherical Cathode and Grid

[Article by I.M. Korzhenevich; UDC 537.533.1]

[Abstract] The shortcomings of high-speed image converters (EOP), e.g., significant degradation of their time resolution with a transition from the center of the field of view toward the periphery, and various methods of decreasing or eliminating the time response distortion are discussed. A new method of significantly improving the time resolution of streak tube image converters on the periphery of their field of view with the help of a cathode and a grid of various curvatures whereby the time resolution in an image converter with electrostatic focusing or with a double magnetic lens improves throughout the entire field of view to the same level as at the center is considered; the method also makes it possible to eliminate the time distortion. The cathode and grid radii of curvature necessary for attaining this result are calculated and the time aberration coefficients (VAK) on these radii of curvature is analyzed. The results of the analytical calculation of the time aberration coefficients are compared those produced by a numerical computation using the author's algorithm (*Radiotekhnika i elektronika* Vol. 35 No. 7) on the basis of two paraxial trajectories and focusing field along the image converter axis. The author is grateful to O.A. Petrokovich for calculating the electron trajectories and I.I. Sharipdzhanov for assistance. Figures 2; tables 1; references 13: 11 Russian, 2 Western.

## On Interferometer Accuracy and Resolution Allowing for Reflection From Earth's Surface

[Article by Ye.A. Lobanov; UDC 621.371.342]

[Abstract] The effect of radio wave amplitude and phase fluctuations due to their propagation in turbulent atmosphere on the measurement accuracy of the angular position of radiation sources determined by antennas and radio interferometers is discussed and the performance accuracy of an interferometer and its resolution as a function of the radiating target observation time, the anisotropy degree of atmospheric inhomogeneities, and the interferometer base position is investigated. For simplicity's sake, only two base positions are considered: vertical and horizontal relative to the earth's plane at low grazing angles of the received signal. The problem geometry is plotted and fluctuations of a random signal received by the interferometer with points located at a certain distance from the earth's surface is considered. The correlation of the received signal's phase difference is derived. The author is grateful to the late A.N. Lomakin for help and support. Figures 4; references 5.

## New Method of Synchronizing Coherent FM Signal Receiver

[Article by P.P. Zagnetov, V.M. Tamarkin, A.N. Lozhkin, and S.V. Kostyayev; UDC 621.373.1:681.514.4]

[Abstract] A coherent demodulator of FM signals with separate synchronization of carrier and clock frequencies is described, independent synchronization of these two frequencies ensuring a wide lock-in band without the drawbacks of most known filtration methods. The demodulator processes an incoming signal which has been amplified first in the high-frequency stage and then in the intermediate-frequency stage of the receiver. The demodulator input stage consists of a quadrature converter pair behind the i-f amplifier. The two converter output signals are fed directly to a regenerator of information-carrying symbols in the demodulator output stage and also to a logic analyzer and generator of logic signals. These signals are fed to a frequency discriminator and a phase discriminator for carrier tracking and also to a clock synchronizer. The two discriminators feed respectively carrier frequency deviation and carrier phase deviation signals back to the converter pair, through a filter and a reference-voltage generator. The clock synchronizer sends a signal to one input of the information regenerator, its other input receiving signal from the two converters directly. This demodulator processes most effectively Gaussian-filtered minimum-shift keyed (GMSK) FM signals with continuous or

constant phase and small modulation index, the quadrature converter pair putting out smooth harmonic quadrature components of such a signal. It also processes but less effectively minimum-shift keyed (MSK) FM signals, the same receiver being recommended for signals of both types on account of their strong similarity. Figures 9; references 3.

### Accuracy Characteristics of Measurement of Signal Source Coordinates in Two-Dimensional Strobe

[Article by I.A. Selivanov; UDC 621.396.969.1]

[Abstract] Measuring the angular coordinates of a signal source in a two-dimensional strobe by the "center of gravity" method is considered, inasmuch as the optimum maximum-likelihood algorithm becomes unwieldy and simple heuristic "beginning and end of pulse packet" algorithms cannot even be readily extended to a two-dimensional strobe. The method involves estimating the coordinates of the energy "center of gravity" of the spatial signal power distribution within the strobe. Its algorithm is analyzed for accuracy in the case of a strobe containing strongly correlated useful signals coming from a single target. Assuming that some sector of space is being scanned by an antenna array in discrete directions passing through nodes of a rectangular azimuth-elevation grid with $\Delta\beta$ and $\Delta\varepsilon$ steps respectively, an expression is obtained for the corresponding probability density function of $\alpha$ or $\varepsilon$ estimates. The efficiency of this algorithm is compared with that of the "least squares" method on the basis of numerical data: $V = V_{max}\sin\theta/\theta$ approximation of the voltage distribution in the major lobe of the antenna radiation pattern, $\Delta\beta$ and $\Delta\varepsilon$ steps of space grid equal respectively to 40 percent and 80 percent of the width of the major lobe at half-power level, signal-to-noise ratio 20 dB in direction of maximum voltage. The statistically optimum algorithm of the "least squares" method is found to be comparable with the algorithm of the "center of gravity" method in terms of the mean-square error of estimates and not to be much more accurate than the latter in terms of maximum error. Tables 1; references 8.

### Simulation of Signals Influenced by Surface Roughness in Goniometric Radar System

[Article by A.A. Monakov, R.V. Ostrovityanov, and G.N. Khramchenko; UDC 621.396.67:621.396.96]

[Abstract] A simple and adequate model of an echo signal returning to a goniometric radar receiver after rereflection by a rough surface is constructed, its reflection by the target being regarded as its emission by a point source of an electromagnetic field whose characteristics correspond to the given signal model. The random signal arriving after rereflection by such a surface is resolved into two components. The specular component is simulated with the field of a image source analogous to the target located underground, symmetrically relative to the fictitious mean surface. The diffuse component is treated as coming from a large target. The complete model of such a signal consists of two expressions describing two complex signals, one in the normalizing channel and one in the weighting channel, assuming that the echo signal arriving directly from the target is fully suppressed in the moving-target selector. As a specific example are considered a rough but plane or cylindrical statistically average horizontal surface and a monochromatic spherical incident echo wave from an isotropic point target, this target being located at an altitude $h_o$ and the antenna which receives the echo signal being located at an altitude $h_a$ above the average surface. The horizontal distance between them is $x_o - x_a = D$. The relative Doppler frequency shift of the rereflected signal increases toward the edges of the signal path and, therefore, a narrow-band filter in the moving-target selector will reduce the size of the rereflecting surface spot. In this case the Helmholtz integral yields, in the Kirchhoff approximation, one general expression for the normalized and weighted signal in the antenna. Its specular component is calculated, approximately, as its average. For this, the distances $r_0$ from surface spot to target and $r_a$ from surface spot to receiver antenna are first each expanded into a MacLaurin series with respect to the vertical coordinate z. The power of its diffuse component is calculated as its dispersion, which is obtained by statistical averaging the signal and expansion of the slowly varying function in the exponent into a Taylor series about the point of specular reflection. Most interesting from the practical standpoint is a rough surface with a correlation length within the intermediate range, in which case the expression for the power of the diffuse component includes the probability integral (error function) as cofactor. When the target moves relative to the receiver antenna, moreover, it is necessary to take into account the spatial correlation of rereflected signals and to calculate the correlation coefficient, which depends on the change of the glancing angle as well as on the change of dimensions and most of all the change of location of the surface spot responsible for formation of a diffuse signal component. For calculation of this component, it is also necessary to take into account the locality of the normal to the rough surface at the point of echo signal incidence and thus introduce another term which includes the derivative of the random function z(x). The shadow effect is accounted for approximately by introduction of the shadow function and the specular signal component is then calculated by direct integration, considering that the random functions z(x) and z'= dz/dx are mutually independent, while the diffuse signal component is calculated by the method of characteristic functions. This model of signals in a goniometric radar

was tested for verification by numerical simulation of such signals in a computer experiment. Figures 2; references 4.

## Conflict Game Model of Radar Target Detection in Countermeasures Mode

[Article by Yu.S. Sukhorukov and V.M. Shlyakhin; UDC 621.396:96:621.391.26:001.57]

[Abstract] A model of target detection by a search radar in the pursuit-and-evasion mode involving countermeasures is constructed in accordance with the theory of games, the theory of search, and the theory of random Markov processes. The model is a two-person conflict game involving interaction of the target capable of countermeasure and the search radar capable of countermeasure. The target is sought within the region of space where its presence is sensed by the search apparatus and countermeasures of the target are initiated immediately after its detection. In this game-duel only one of the two players is subject to being harmed upon its detection by the opponent. The target and the search radar assumed to have equal countermeasure capabilities, which include not only varying the contrast but also generating interference signals for masking and imitative deception. The efficiency of the search radar is estimated in terms of the probability of target detection within a given time period. For each player, on the basis of this model, is devised a pure strategy of anticipating the moves of its opponent and thus optimizing its countermeasure. In a prolonged conflict game executed with pure strategies one of the players may be eventually harmed, when the opponent has sufficient time to identify his strategy. It may then be advisable for each to employ a probabilistic or mixed strategy. Figures 4; references 3.

## Generalized Intrinsic Polarizations of Radar Target

[Article by N.N. Badulin, V.V. Bylina, V.L. Gulko, K.G. Sokolov, and Ye.L. Shoshin; UDC 521.396.96]

[Abstract] The concept of intrinsic polarization of a target is examined for validity in radar polarimetry, this concept being based on two basic assumptions. The first assumption is that for any radar target there are possible at least two polarizations of the incident signal field making the polarization ellipse of the scattered field coincide with the polarization ellipse of the incident one. The second assumption is that their polarizations are always mutually orthogonal so that the scattering matrix of any target becomes a diagonal one in some orthogonal polarization basis. The formal significance of these assumptions is analyzed from the standpoint of measurement of a target's polarization characteristics. The two assumptions are shown to be contradictory in some cases such as a one-position radar with two dipole antennas, where the scattering matrix is symmetric but consists of complex-number rather than real-number elements and thus cannot be transformed into a diagonal one. This contradiction is overcome by introducing the concepts of a generalized intrinsic polarization and a generalized matrix eigenvalue. The problem then reduces to determining a group of real-number polarization parameters completely defining the polarization characteristics of a target. Figures 2; references 5.

## Experimental Study of Effect of Extraneous Resonance Fields on Emission Power of He-Ne Laser

[Article by A.N. Martyanov, V.G. Tatsenko, and E.V. Borisov; UDC 621.3.013.001.5:621.373.826]

[Abstract] An experimental study of a He-Ne laser emitting 0.63 $\mu$m radiation was made concerning interaction of its active medium neon and extraneous radiation fields at resonance with other allowed radiative transitions in the four-level quantum system which neon is: $3s_2 \to 3p_4$ (3.39 $\mu$m radiation) and $2s_2 \to 2p_4$ (1.15 $\mu$m radiation). The apparatus included this principal He-Ne laser between two sets of calibrated diaphragms regulating the pump power. It also included two commercial He-Ne lasers: a 3.39 $\mu$m LG-126 and a 1.15 $\mu$m LG-65, each followed by an optical radiation intensity modulator and then a band filter preventing interaction of their radiation fields. Radiation emitted by the principal laser was passed through a beam-splitter mirror to a photodetector, an interference filter in front of the latter preventing simultaneous direct incidence of extraneous radiation. Measurements were made with a mirror milliammeter or a spectrum analyzer. The first test was performed for the purpose of determining the dependence of the power $P_1$ of 0.63 $\mu$m radiation emission by the principal laser on the power $P_e$ of 3.39 $\mu$m radiation emission and of 1.15 $\mu$m radiation emission by each respective laser alone and by both lasers simultaneously. The increment of 0.63 $\mu$m radiation emission power $\Delta P_1$ was determined from the output current of an FEU-28 photomultiplier, the latter having been set for measurements within the linear range of its power-current characteristic by rising its entrance aperture. The second test was performed for tracking the allowed $3s_2 \to 3p_4$ or $2s_4 \to 2p_4$ transition in the active medium of the principal laser and for determining the power ratio $P_e/P_1$ corresponding to the maximum ratio $\Delta P_1/\Delta P_e$ of respective power increments. This test was performed with one extraneous radiation field at a time and with two extraneous radiation fields simultaneously, in the latter case with the two other lasers on opposite sides of the principal one. The intensity of each radiation was either

held constant or 100 percent modulated with a meander signal, at different frequencies so as to facilitate separation of signals carrying a different radiation. An analysis of the results confirms earlier predictions that extraneous resonance radiation of any of the the given wavelengths decreases the radiation emission power of a 0.63 $\mu$m laser, but by different mechanism in each case. Extraneous radiation at resonance with 3.39 $\mu$m radiation depletes the upper level $3s_2$ by stimulated transfer of active atoms to the ground level $2s_4$. Extraneous radiation at resonance with 1.15 $\mu$m radiation enhances the ground level $2s_4$ with active atoms from the upper level $2s_2$. In both cases the population difference between level $3s_2$ and level $2p_4$ decreases so that also the power of radiation emission attending the 0.63 $\mu$m $3s_2 \rightarrow 2p_4$ transition decreases. Because depletion of the upper level is more intense than enhancement of the lower level, however, extraneous 3.39 $\mu$m radiation decreases the emission power of a 0.63 $\mu$m laser more than does extraneous 1.15 $\mu$m radiation. Simultaneous action of both extraneous radiation fields was found to be attended by "competition" and "suppression" effects. Figures 5; references 1.

## Automatic System for Noise Spectroscopy of Semiconductor Structures

[Article by M.D. Vorobyev, N.G. Kokhanov, S.M. Skliznev, and L.P. Smirnov; UDC 621.382.002.3:620.179.1.005]

[Abstract] A fully automatic system for nondestructive inspection of semiconductor devices by the method of noise spectroscopy is described, the purpose of such an inspection being to determine the parameters of trap centers associated with defects in the semiconductor material. The system is designed to measure the spectral density of voltage fluctuations attending passage of a direct current through a semiconductor test specimen and to determine its temperature dependence at several fixed frequencies. According to the theory of generation-recombination noise, its spectral density can pass through one only peak or through several peaks within a given temperature range. Each maximum along the temperature scale indicates the dominant mechanism of charge carrier transfer from traps of one kind to other traps of the same kind and from one allowed energy band to another. The temperature shift of each maximum attending a change of frequency provides a basis for determining the concentration and the energy level of given traps within a band as well as their effective cross-section for capture of charge carriers. The inspection process is controlled by a MERA-660 microcomputer, with a TV monitor and a MERA-620 flatbed graph plotter. The inspection apparatus includes a thermocryostat with temperature regulation from -60° to

+16°C. With a semiconductor specimen inside this thermocryostat, the noise voltage appearing across its contact tabs during passage of a direct current through it boosted by a low-noise preamplifier and then an amplifier for processing by an AS-20 parallel-operation spectrum analyzer. This spectrum analyzer consists essentially of 12 filters so that measurements can be made at 12 frequencies spaced uniformly over a logarithmic scale covering to 0.02-100 kHz range. The filters, second-order band filters based on 140UD6 operational amplifiers with frequency-dependent feedback and a Q-factor of about 6, are each followed by a linear detector and then an integrating R-C circuit with a time constant selected so as to ensure that the error of a one-shot noise voltage measurement not exceed 10 percent. One can improve the accuracy of inspection further by repeating the measurement and averaging the results. The spectrum analyzer includes a decoder controlled by analog switches so that the analyzer output signal is a constant voltage proportional to the spectral density of the noise voltage measured with a V7-16 digital voltmeter in each frequency channel. The spectrum analyzer also includes an optron which controls the thermocryostat. The decoder is built with series 155ID3 IC components and the switches are built with series 176KT1 IC components. The sensitivity of the apparatus is not worse than $10^{-17}$ $V^2$/Hz at frequencies below 1 kHz and $10^{-18}$ $V^2$/Hz at frequencies above 1 kHz. One measurement of the noise spectrum covering all 12 channels takes about 1 min. The inspection system was tested on an AA723A Gunn-effect diode with two peaks of the spectral density of noise voltage fluctuations within the 200-400 K temperature range. Spectrum analysis covering this temperature range was completed within about 1 h and the parameters of one kind of trap centers were calculated within about 5 min. Figures 2; references 1.

## Statistical Evaluation of Results of Quasi-Steady Electromagnetic Field Identification

[Article by V.Ya. Lavrov, candidate of technical sciences, and A.P. Pukhanov, Leningrad Institute of Aviation Instruments Design; UDC 537.811:681.5.015.42]

[Abstract] The problem of statistically evaluating the results of identification of quasi-steady electromagetic fields for a reliability analysis of these results is formulated, considering that a reliability analysis makes sense only when identification has been made on the basis of a stochastic rather than deterministic mathematical model. Measurements of magnetic field intensity H(r) or electric field intensity E(r) on a base surface S are assumed to have been made at several points on this surface, the location of each point defined by its radius-vector r, and Q independent measurements made at each point to have yielded a normal distribution of field intensity readings. As typical is considered identification made in a spherical system of coordinates on a surface of

revolution and specifically a cylindrical one as the base surface, the results of identification yielding normally distributed integration constants $A_{mn}$ and $B_{mn}$ with indices m,n denoting the distribution parameters. The parameters to be statistically evaluated are mean values and dispersions of $A_{mn}$ and $B_{mn}$ samples. The procedure applies to any other model of an electromagnetic field. It is demonstrated numerically on experimental data pertaining to a plane-meridional magnetic field. Figures 1; tables 1; references 8.

## Method of Calculating Reradiation of Electromagnetic Signals by Holes and Inhomogeneities in High-Frequency Shielding Shells

*927K0141B Kiev TEKHNICHESKAYA*
*ELEKTRODINAMIKA in Russian No 6,*
*Nov-Dec 91 pp 23-26*

[Article by A.I. Titko, doctor of technical sciences, and M.V. Shalomygin, Institute of Electrodynamics, UkSSR Academy of Sciences, Kiev; UDC 621.391.82.016.35]

[Abstract] For a design and performance analysis of high-frequency shielding shells usually made of a metal which has a high electrical conductivity, the effect of their imperfections such as holes, gaps, or other inhomogeneities is calculated in terms of the electromagnetic leakage field of signals reradiated by them. The waveform of such a signal, not necessarily a rectangular pulse, is taken care by expansion of the signal into a Fourier series and then considering not only the amplitudes of its harmonic components but also the phase relations between them. Calculation of the leakage field then follows in two steps. First is calculated the surface current density on a smooth shell without inhomogeneities, which can be done by any suitable known method but most effectively by a variational method in the case of intricate shield boundaries and internal field sources. In the second step inhomogeneities of any shape are simulated with rectangles oriented in the direction of flow of the surface current so that the latter will split into longitudinal and transverse branches as it passes around them. Assuming this to be a near-field situation, the surface current around each inhomogeneity is resolved into six components in a common system of coordinates for subsequent calculation of the resultant reradiated electromagnetic field. This model offers the possibility of approximating inhomogeneities of any shape for signals covering a wide frequency range, the possibility of describing different inhomogeneities with the same set of geometrical elements by using the same calculation program, and adaptability to intricate distributions of surface current density. Another important advantage of this model over the dipole model is the possibility of representing the contour of an inhomogeneity by an equivalent electric circuit and thus also determining the phase relation between currents so that the constraint of a quasi-steady electromagnetic field limiting the size of inhomogeneities can be removed. The computer program of calculating reradiated electromagnetic fields on the basis of this model was tested on a copper shield against a 10 MHz electromagnetic field, a shield with reradiating holes of various shapes and sizes but not directly penetrable by the external field. Figures 3; references 4.

## Interaction of Pulsed Electromagnetic Fields and Multiconductor Electric Power Transmission Line

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*ELEKTRODINAMIKA in Russian No 6,*
*Nov-Dec 91 pp 26-30*

[Article by A.F. Onanko, UkSSR State Institute of Power Transmission Network Planning; UDC 621.311]

[Abstract] A method is proposed for calculating the amplitude-time characteristics of currents induced in overhead electric power transmission lines by short pulses of an external electromagnetic field. The method is applicable to multiconductor lines, taking into the interphase couplings as well as influence of the ground surface. The interaction of an external electromagnetic field and a high-voltage transmission line is described by a matrix of telegrapher's equations and the boundary-value problem for these nonhomogeneous equations is solved by the method of wave channels, the amplitude-time characteristics of the currents then being calculated by inverse Fourier transformation. The external field is assumed to be that of a plane electromagnetic wave incident in the form of an exponential pulse $E(t) = E_M[\exp(-\alpha t)-\exp(-\beta t)]$ with a given amplitude $E_M$ and an arbitrary linear polarization. The overhead transmission line is assumed to be a straight homogeneous multiconductor array above a plane ground surface. Calculations for the field reflected by the lossy ground surface are made with use of complex Fresnel coefficients and finiteness of the electrical conductivity of the lossy soil is accounted for by use of Carson integrals. The effect of pulsating corona at the surfaces of conductors is disregarded. On the basis of these premises, the method is demonstrated on high-voltage overhead transmission lines operating in the matched mode under a frequency-dependent load. As a specific example is considered 330 kV line on a support structure rising to a 10 m average altitude above ground, struck by a plane electromagnetic wave incident in the form of a pulse with $\alpha = 1.6 \times 10^6$ s$^{-1}$ and $\beta = 2.8 \times 10^8$ s$^{-1}$ time constants, the average electrical conductivity of the soil being 0.01 S/m. Figures 2; references 9.

## Current-Induced and IR Laser-Induced Electron Emission from Specially Structured Gold and Graphite Films Induced by Current Flow or Infrared Laser Radiation

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*ELEKTRONIKA in Russian Vol 36 No 7,*
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[Article by L.V. Viduta, O.E. Kiyayev, A.G. Naumovets, A.P. Ostranitsa, and R.D. Fedorovich; UDC 537.533.2]

[Abstract] An experimental study was made concerning mechanisms of electron emission from of nesocatenary films, electron emission from such gold films induced by passage of electric current and electron emission from such graphite films induced by incidence of infrared laser radiation. Chains of periodically spaced identical film islets were deposited by thermal evaporation or other methods on parallel slopes of periodic V-groove diffraction gratings with a 1.6 $\mu$m period cut into dielectric substrates, gold films on glass substrates and graphite films on silicon substrates. There were sufficiently many gold film islets in each chain and their spacing was sufficiently close to provide a linear path for passage of electric current, while the spacing of chains was sufficiently wide to minimize the transverse electrical conductance and thus provide a barrier to shunting currents. The deposition process was, moreover, so controlled as to allow varying the shape and the size (dispersion) of film islets. While all gold films were deposited by vacuum evaporation, three kinds of graphite films were deposited by three different methods each: 1) islets in the 1-10 nm size fraction deposited by vacuum evaporation; 2) islets in the 30 $\mu$m size fraction deposited through a mask and consequently surrounded by clouds of much smaller ones; 3) islets of the 1 $\mu$ size fraction deposited by a special method. The films were tested for dependence of the electron emission current on the dispersion of islets and on the periodicity of their anisotropic structure. The gold films were excited by passage of electric current upon application of an adjustable voltage, electron emission then being measured with a U1-2 electrometer. The graphite films were excited by a $CO_2$-laser of adjustable power emitting 10.6 $\mu$m radiation in pulses of 1 $\mu$s duration, electron emission then being recorded with an S1-13 oscillograph. Measurements were made with hermetic vacuum instruments, BaO monolayers having been deposited on specimens for lowering the work function and heat regulation having been included for varying the substrate temperature over the 77-290 K range. The electron emission current was measured in the saturation mode with a 10 kV/cm average intensity of the extracting electric field at the anode, using a U1-2 electrometer when films were being excited by passage of an electric current and using an S1-13 oscillograph when films were being excited by infrared laser radiation pulses. The data on current-induced electron emission from such films reveal that the electron emission current $I_e$ decreases as the voltage V across the film chains is raised or as the Joule-effect heating power P thus injected into the film rises. They appear to fit the Fauler-Nordheim field emission characteristics in log $I_e$-$V^{1/2}$ and log $I_e$-$P^{1/2}$ coordinates, their slopes decreasing with rising temperature. The linearity of these characteristics over a wide range does not definitively prove this to a case of field emission, although it could be, while recorded accompanying equilibrium thermoluminescence indicates that it could be thermoelectron emission by the electron gas heating mechanism. Deviation from linearity was found to occur only under high voltages, evidently owing to the Schottky effect. The data on laser-induced electron emission from such films reveal that in this case the electron emission current increases sublinearly with rising power surface-density of incident infrared radiation pulses, this definitely not being field emission and very unlikely to be thermoelectron emission. The authors thank P.M. Tomchuk for helpful discussions and P.F. Romanenko for assistance in preparation of specimens. Figures 6; references 15.

## On the Path Toward New Dispatcher Control, Signaling, and Communication Systems

[Article by G.V. Novik, Belarussian Railroad]

[Abstract] The impact from the implementation of the Computer-Aided Road Dispatcher Center (DADTsU) and the need to retrofit and upgrade much of the railroad equipment, particularly the equipment of the centralized traffic control sections and centers, replace aerial communication links with cable lines, develop a new communication network structure on the basis of a hub and spoke principle, and equip operator workstations with computers are discussed and the expediency of providing data received over dispatcher center (DTs) channels not only to train dispatchers by to staff at other services and subdivisions, including E and Sh service dispatchers, is analyzed. The urgency of upgrading communication networks in Minsk is emphasized; the importance of developing an alternative centralized traffic control system in order to maintain competitiveness and prevent monopolization is stressed. It is noted that the development of the automated railroad dispatcher center will not only improve the traffic control efficiency but will also considerably reduce operating costs.

## Problems of Developing Telemetry Network for Computer-Aided Road Control Center

[Article by D.V. Gavzov, M.V. Ilyukhin, A.P. Koshelev, O.Ye. Petrovskaya, Leningrad Railroad Engineers Institute; UDC 656.256.05:621.398]

[Abstract] Development of an extensive telemetry network encompassing all railroad stations and allocation communication channels to these stations dictated by the need to transmit data on the train position from signaling, interlocking, and blocking (STsB) systems to regional or railroad centers and sending command instructions in the opposite direction is discussed. Telemetry network channels must ensure data transmission at a high confidence level in a volume sufficient for developing dynamic information models of the train positions. It is suggested that information streams from several dispatcher center systems be combined in a single channel and a block diagram of such an integrated structure is cited. The principal information characteristics of railroad automation devices used as message sources in the Computer-Aided Road Control Center (ATsDU) are considered and control data are divided into three categories. Expedient methods of setting up nontraditional data transmission channels for Computer-Aided Road Control Centers over engineer and operator communication circuits of the signaling, interlocking, and blocking system and RF communication lines are considered; to check the method, a channeling equipment model operating within a 4-12 kHz band is developed. An analysis of the

model operation shows that existing cable and aerial lines are suitable for setting up such a nontraditional channel for data transmission at a 1,200 baud rate. Implementation of telemetry concentrators and additional multiplexing of physical lines with service channels makes it possible to develop data transmission networks with minimal physical, labor, and financial outlays. Figures 7.

## Issue of Property at Railroad Enterprises

[Article by V.G. Gizatullina, O.G. Bychenko, Belarus Railroad Engineers Institute]

[Abstract] The role of ownership of the means of production in railroad management is discussed in the light of the USSR Law of Railroad Transport which outlines the basis of economic relations and production processes in the industry. Two versions of commercial relations between the railroad station automation department or division and the station itself under normal economic conditions are considered using the example of the Gomel Railroad Station of the Belarussian Railroad; to this end, the revenue realized from the use of the locker rooms and its distribution are calculated and the profit and profitability margin are determined. Provision is made for reimbursing the station for equipment operation failures.

## Problems of Servicing Automation and Communication Devices Which Arose After Chernobyl Nuclear Power Plant Accident

[Article by A.S. Savelyev, Belarussian Railroad]

[Abstract] The problems of servicing blocking and interlocking devices and communication systems and railroad divisions in areas with varying degrees of radioactive contamination resulting from the Chernobyl nuclear power plant accident are discussed. The problem of high personnel turnover due to the unavailability of affordable housing and food stocks in clean areas is also discussed. A number of government decrees which provide for paying a 30-50 percent surcharge depending on the contamination degree (from 5 to 15 $Ci/km^2$) is outlined. Implementation of interlocking, blocking, and communication automation devices which make it possible to shorten the personnel stay in the contaminated areas is considered and the lack of interest in remediating the situation on the part of the Railroads Ministry and the Chief Logistics Directorate is noted. It is stressed that poor mechanization and slow pace of implementation of new devices lead to a high number of resignations which, in the final analysis, makes it difficult to maintain the equipment at a proper level.

## Scientific Studies and New Developments in Electrical Measurement Instrument Building (Current Trends and Features)

*927K0215A Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 11, Nov 91 pp 2-3*

[Article by V. N. Ivanov, director of the All-Union Scientific Research Institute of Electrical Measurement Devices; UDC 621.317]

[Abstract] Changes in the economy have prompted a substantial change in the demand for electrical measurement instruments. There has been a general decline in the demand for these devices, and the largest drop in demand has affected high-current universal digital instruments and measurement and computing complexes based on domestic computer equipment. However, there has been some increase in demand for devices for commercial accounting of power consumption, built-in instruments, and components for specialized devices. These devices are now being used in nontraditional areas (farming, production and service cooperatives, small businesses, municipal services, etc.). Areas financed by the government budget have experienced a serious decline in demand, for example, science, the defense industry, large industrial construction projects, and atomic energy plants. The change in government investment policy has also affected the development of new equipment. Previously, 10-25 million rubles were provided annually for research and development; in 1991 central funding virtually ceased. Trends for future development include greater specialization, the creation of "smarter" devices using microprocessors and modular construction, and the use of microelectronics. The institute has used its own resources to produce integrated semiconductor pressure sensors, measurement information systems for electric and magnetic fields, and silicon photoreceptors. The production and delivery of various types of electrical measurement instruments increased by a factor of 4 over 1990, and this comprises about 25 percent of the institute's work conducted using it's own resources. The importance of keeping pace with world developments in the field, and participation in international organizations is recognized.

## Control Systems for Special Technological Equipment

*927K0215B Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 11, Nov 91 pp 7-9*

[Article by V. G. Krylov and A. M. Polonskiy; UDC 681.3:66.012]

[Abstract] This article analyzes the requirements imposed on control systems intended for automation of technological processes in the petrochemical, metallurgical, and other industries. The problems of providing continuous reliable operation of control systems and the implementation of redundancy are discussed. Two generations of control systems based on redundant structures using hardware and software to increase reliability are examined. The basic specifications of these systems are presented. In these control systems, real time monitoring and process control demand a multiprocessor, multi-level implementation. In the second generation system, a LAN connects the control panel to up to 31 devices for information exchange. The system performs automatic self-testing and diagnosis and uses an IBM PC/AT type personal computer. The device for communication with the controlled object provides 32-256 input-output channels for discrete signals and 60 for analog input. Constant voltage from -5 to +5 V, and constant current from -5 to +5 mA are measured. There is a 0.4-1.5 percent measurement error for this device. The system runs on 220 V (50 Hz). Figures 3; table 1; references 3 (Russian).

## Magnetically-Controlled Integrated Circuits With Enhanced Sensitivity

*927K0215C Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 11, Nov 91 pp 12-13*

[Article by G. V. Abramzon, Ye. I. Andreyev, T. V. Persiyanov, Yu. N. Smirnova, and N. I. Yakovlev; UDC 681.586:681.325.5-181.48]

[Abstract] Basic principles of construction of two types of magnetically-controlled integrated circuits are examined: those based on the use of a multi-collector magnetoresistor and thin film magnetoresistive elements. Data is presented on the manufacturing procedure, design principles, and specifications, as well as the operating paramters of the integrated circuits. The drawbacks of existing magnetic field sensors are outlined. The article describes magnetically-controlled switching circuits: a silicon monolithic integrated circuit which is manufactured using standard KMOS technology and a magnetoresistive integrated sensor which uses hybrid thin film technology. The sensitive element in the monolithic integrated circuit is a lateral bipolar multi-collector magnetoresistor. This can be used as a high-quality position detector and as a sensor for collectorless electric motors. The thin film magnetoresistive elements are very promising because of their high sensitivity and stability, as well as their ability to work in extreme conditions (temperatures up to 150° C and beyond). Studies have shown that magnetoresistive elements can be used to measure magnetic fields or as current transformers. They can also be used as sensors of angular and linear displacement, position, velocity, number of rotations, moment of rotation, pressure etc. Figures 2; tables 2; references 7: 3 Russian 4 Western.

## Preparation for and Certification of Products at the Elektromera Interbranch State Association

*927K0215D Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 11, Nov 91 p 20*

[Article by V. N. Semenov and A. A Krupenin, respectively, deputy director and department head at the

All-Union Scientific Research Institute of Metrology, Testing, and Standardization in Instrument Building; UDC 681.2.006.44]

[Abstract] On 1 January 1992 the USSR enacted a law to protect the rights of consumers. The consumer has the right to expect that the use or storage of a product will not endanger his life, health, or property over the course of a certain period of time. Standards to ensure this and environmental safety have been established. Products must be certified and marked with a symbol indicating that it is certified. It is illegal to buy and import uncertified products into the USSR. The Scientific Research Institute of Metrology, Testing, and Standardization in Instrument Building, realizing the urgency of this problem, has developed and is preparing to implement the Program To Prepare the Enterprises of the Elektromera Interbranch State Association for Certification. This program involves the following: preparation of a list of products to be certified; analysis of testing facilities, and the selection and preparation of testing laboratories for accreditation according to government standards; analysis of government standards to see that they meet international standards for safety, environmental protection, and compatibility; and the creation of a national bureau for certification of instruments. Reference 1 (Russian).

## Problems of Standardization of Instruments in Market Conditions

*927K0215E Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 11, Nov 91 p 21*

[Article by V. P. Sobolev; UDC 681.2:334.75:006]

[Abstract] The massive amount of "obligatory" standards and guidelines inundating enterprises has not served to increase the quality and technical sophistication of products. Rather, they have led to the development of new standards and the stifling of creative work to improve products and to get in touch with consumer needs. Standards are hindering the USSR's participation in international cooperations. It is necessary to see the standard not only as a directive establishing technical requirements, but also to compare the goals of the standard with the cost of its introduction, primarily in terms of products which have already been developed. International standards must also be considered with caution, because in many cases they involve procedures, materials, and testing methods unused in the USSR. A more appropriate measure is the USSR law on the protection of consumer rights, which mandates certification of products and identification of certified products with a symbol. Two technical committees have been established to develop standards and to improve general technical and general system requirements in instruments, primarily requirements for safety, environmental protection, and compatibility. Another important step is the creation of a standardization bureau to coordinate the activities of the technical committees, to establish priorities for work on standardization, quality assurance, testing, and certification, to implement accreditation programs, and to establish independent testing centers.

## Preliminary Results of Unit Waveguide Thermal Noise Generator Certification Method

*927K0193A Moscow IZMERITELNAYA TEKHNIKA in Russian No 9, Sep 91 pp 14-15*

[Article by O.G. Petrosyan, M.V. Sargsyan; UDC 621.317.757:658.562]

[Abstract] A method of certifying waveguide thermal noise generators as a unit—a modification of the element-by-element certification method with the help of an auxiliary waveguide transmission line—is considered. In contrast to the old method, the unit methods make it possible to measure the effective noise temperature of the thermal noise generator (TGSh) without measuring the electromagnetic wave attenuation factor and temperature distribution in the thermal noise generator channel beforehand. The unit method requires two noise generators with known load temperatures and a radiometer comparator. A block diagram of the method and a schematic diagram of a cryostat developed for its realization are cited and the characteristics of the two methods are compared. An analysis of the method with the help of a specially developed software package demonstrates that it is quite competitive and promising. It is noted that the method's random error can be lowered by placing a insulating attenuator in the cooled waveguide section thus making it possible to limit ourselves to only one connecting circuit. Figures 2; tables 1; references 2: 1 Russian, 1 Western.

## Slow Wave System Element Configuration Monitoring

*927K0193B Moscow IZMERITELNAYA TEKHNIKA in Russian No 9, Sep 91 pp 15-16*

[Article by V.M. Demin, L.I. Kalinina, Yu.V. Filimonov; UDC 531.7.083.2:621.372.4/.6]

[Abstract] The need to monitor the parameters of the slow wave systems of the coupled resonator network (TsSR) type widely used in traveling wave tubes (LBV) is stressed and a device which makes it possible to monitor the integrated geometry of the slow wave system elements developed by the authors on the basis of the radio engineering method is described. A block diagram of the device is cited and the operating principle of its components is outlined. The device measures the integrated element's configuration and its deviation by measuring the resonance frequency deviation of a standard resonator. The principal unit of the device is a sweep frequency oscillator (GKCh). The control and data processing unit is executed on the basis of a single-chip K1816VYe35 microcomputer; the element parameter deviations from specifications are analyzed and displayed. The device operates in the centimeter band and monitors standard resonator frequency deviations from

a given value within 0-20 MHz. The resonance frequency deviation measuring resolution is no more than 0.1 MHz and the reference marker frequency deviation measurement resolution is no more than 0.01 percent. The device has a $Q$-factor measurement range of 500-10,000 and a measurement error of no more than 5 percent. Figures 1; references 1.

## Method of Generating Precision Amplitude-Modulated Signals

*927K0193C Moscow IZMERITELNAYA TEKHNIKA in Russian No 9, Sep 91 pp 57-60*

[Article by M.Ya. Mints, V.N. Chinkov; UDC 621.317.341[088.8]]

[Abstract] Metrological support development trends and the shortcomings of the analog amplitude-modulated (AM) signal generation method for instrument signal calibration are discussed and the use of amplitude-pulse modulated (AIM) signals generated with the help of digital circuitry for designing precision AM signal calibrators is considered. The amplitude-pulse modulated signals can be generated with high precision. The amplitude-pulse modulated signal is converted to an AM signal using a band-pass filter tuned to the base frequency of the pulse carrier or its harmonic, making it possible to form, when necessary, a spectrum of AM signals in various frequency bands on the filter output from one amplitude-pulse modulated signal. The errors resulting from the use of amplitude-pulse modulation and the resulting decrease in the output calibrator signal generation accuracy are analyzed and a method of estimating these errors is proposed. A block diagram of the AM signal calibrator is cited. The calibrator's advantages are summarized and its is noted that the development of

digital AM signal calibrators on the basis of the amplitude-pulse modulation method with subsequent narrow-band filtering ensures their high metrological characteristics which meet not only today's but also tomorrow's requirements imposed on this type of instruments. Figures 2; references 1.

## Increasing Accuracy and Efficiency of Small Signal Harmonic Coefficient Measurements

*927K0193D Moscow IZMERITELNAYA TEKHNIKA in Russian No 9, Sep 91 pp 60-62*

[Article by I.A. Teshev; UDC 53.088]

[Abstract] The shortcomings of harmonic distortion factor meters (INI) for measuring very low harmonic distortion factors (<0.002 percent) are outlined and it is shown that their high error is due to an insufficient dynamic range; the task of solving this problem and automating the measurement process and increasing its efficiency with the help of devices and microcomputers connected to a common bus is formulated. An automated workstation for checking audio frequency oscillators is described and its block diagram is cited. In addition to measuring the harmonic distortion factor, the circuit makes it possible to perform spectral analyses of the signal under study in the following three cases: when the noise voltage is substantially lower than the higher signal harmonic voltage and the circuit measures the amplitude ratio of the third/second harmonics; when the noise voltage is significantly greater than the higher signal harmonics voltage and the circuit indicates that the signal spectrum consists of noise alone; and when the noise and higher signal harmonics voltages are commensurate and the circuit measures their ratios. The accuracy of the harmonic distortion factor measurement depends on the spectral composition of the signal under study. Figures 1; references 3.

## Two-Port 256/1000 kbyte Memory With up to 10 Mbyte/s Speed

[Article by S.V. Golovkin, Institute of High-Energy Physics, Serpukhov; V.V. Golubev and A.B. Sheynin, Scientific-Industrial Association "Pulsar", Moscow; Ye.N. Kozarenko, Joint Institute of Nuclear Research, Dubna; UDC 539.107]

[Abstract] A high-speed two-port 256/1000 kbyte cache memory has been developed for computer-aided optical measurements with multichannel telecameras built on the basis of CCD (charge-coupled device), this memory being capable of effecting data exchange at its lead-in port at an up to 10 Mbyte/s speed. A memory module is a double-width CAMAC or SUMMA module with both input and output connector sockets as well as light-emitting diodes as visual indicators of operating mode and states, all on the front panel. An address of arbitrary length is recorded in the memory and read from it by two successive appropriate signals, address increments being added automatically in the continuous mode by means of a RAS signal within the conventional about 400 ns long memory cycle. Each module consists of a command decoder, a control and states logic, a memory address regenerator, a memory cycle generator, an address counter, a record/read length counter, two multiplexers with a data buffer each, a 64K x 32 and 256K x 32 memory array, and a data transfer control. The memory operates with NAF*, S1, CLOCK, CYCLE, RAS, CAS-WE, STROBE RD signals in the CAMAC mode and with INHIBIT, STROBE IN, STROBE 1, STROBE 2, STROBE 3, STROBE 4, DATA IN, CLOCK, CYCLE, RAS, CAS-WE, STROBE RD signals in the front-port mode, in the latter case with STROBE IN - INHIBIT - CARRY OUT and CARRY IN - STROBE OUT on that side. Operation in the front-port mode is possible with 8-bit and 16-bit words. In this mode regeneration needs to be interrupted by the INHIBIT signal during each strobe, application of this signal throughout the record and read time being allowable when the frequency is above 100 kHz. Overflow of a counter in any of the two operating mode causes a reset of LAM, if allowed, while Q becomes blocked. Figures 4; references 7.

## Cryogenic Hypersonic Delay Line for EHF Millimeter-Wave Radio Signals

[Article by Ye.M. Ganapolskiy, Institute of Radio-physics and Electronics, UkSSR Academy of Sciences, Kharkov; UDC 621.374.55]

[Abstract] A cryogenic hypersonic delay line for EHF radio pulse signals in the 8 mm band is described, deep cooling of the acoustic waveguide to 4.2 K with liquid helium being required for ensuring an adequately high signal-to-noise ratio in an EHF-receiver during measurements by the interference method. The device consists of an acoustic waveguide and an electrodynamic cavity waveguide-resonator separated by a piezoelectric ZnO film with grain orientation on an aluminum sublayer. The acoustic waveguide is a synthetic sapphire crystal in the form of a 17.6 mm long rod 2.6 mm in diameter with "optically" flat and parallel end faces. Cooling it so deep below the about 400 K Debye temperature minimizes its absorption of hypersound it to residual coherent scattering by elastic inhomogeneities in the crystal. The electrodynamic resonator is a rectangular waveguide segment with stainless steel walls, also "optically" flat at both ends, and a channel-cavity in the form of two identical round slots connected by a narrow slit between two parallel flat copper crowns lining the opposite walls. The cavity is at one end covered by that piezoelectric ZnO film coupling it to the acoustic waveguide and at the other end connected to a standard rectangular 5.2 x 2.6 mm$^2$ channel of a waveguide connecting it to the radio antenna. The entire structure is placed in a hermetic container with liquid helium and with an outlet on top for the antenna. An incoming EHF radio pulse signal passes through the resonator-waveguide to the piezoelectric film, which converts it into a hypersound pulse. This hypersound pulse enters the acoustic waveguide and travels through it to the end, then reflected by the back face of the sapphire crystal returns to the piezoelectric film for reconversion into the EHF radio pulse. The radio pulse, thus delayed by the time it took for the hypersound pulse to travel back and forth through the acoustic waveguide, then returns through the resonator-waveguide and the standard radio waveguide to the antenna. This delay line, designed and built for optimum performance, can delay a 35 GHz pulse signal of 0.5 μs duration by at least 3.2 μs with a signal loss not exceeding 70 dB within a 1.5 GHz passband. Figures 3; references 7.

## Set of Pyroelectric Transducer for Measurement of Laser Radiation Energy and Power

[Article by S.V. Grinik, L.S. Kremenchugskiy, S.K. Sklyarenko, and A.G. Chepilko; UDC 536.52:517.226.82]

[Abstract] A set of four pyroelectric transducers is available for measurement of the average radiation power in laser beams with effective diameters ranging from 2 mm to 25 mm, with a relative error smaller than 5 percent. These transducers cover the 0.01 μW - 20 W range of average power for continuous-wave laser radiation and the 0.01 μW - 1 mW range of average power for periodically pulsed laser radiation with 0.01 μJ - 0.1 J energy per pulse. The housing of the PV-1 transducer includes a

hemispherical mirror with a 5 mm wide window-diaphragm. The housings of the other three transducers have inlet windows respectively 12 mm in diameter (PV-2), 30 mm in diameter (PV-3), and 5 mm in diameter (PVD-1). All four transducers are vibration-proof, vibration noise within the 2-200 Hz frequency range being reduced to the a level close to thermal noise. The set of transducers was tested with radiation of 0.63 μm, 1.15 μm, 3.39 μm, 10.6 μm wavelengths for calibration against cavity transducers and a master reference standard of laser radiation. The nonuniformity of their spectral characteristics does not exceed 1.4 percent over the entire 0.63-10.6 μm range, the spectral nonuniformity of PV-1 and PVD-1 transducers having been measured by the laser beam defocusing method and not exceeding 1 percent. All four transducers have been certified at the Volgograd branch of the Saratov Metrological Service and Standardization Center for use with a PVDTs-2 watt-and-joule meter. Tables 1.

## Infrared Instrument for Quick Field Thermography

[Article by S.G. Korniyenko and V.G. Osipov, Institute of Problems in Geothermometry, Dagestan branch, USSR Academy of Sciences; UDC 621.384.326 + 681.327.6]

[Abstract] An infrared instrument for recording radiation temperatures of the earth's surface with a hand-held thermograph is described, this instrument picking up 3-5 μm and 10-13 μm infrared radiation and storing the data on a magnetic tape. The radiometer inside a housing with a thin lid consists of two spectral channels, one for each radiation band. Each channel includes a reference radiator followed by a photodiode and a common rotating shutter driven by an electric micromotor. Behind the shutter each channel continues with an electric lamp, an optical filter, a concave spherical mirror, and a pyroelectric radiation transducer. One of these transducers feeds signals into an electronic system consisting of an input amplifier stage followed by a commutator switch also receiving signals from a photoamplifier and sending signals through a low-pass filter to a differential amplifier which, together with a thermal-compensation amplifier feeds signals to a computer for data processing and subsequent storage. The data storage operates in the one-frequency mode with separate tracks for "1" and "0" levels, which ensures regularity of record-read signals and facilitates their self-synchronization in case of possible tape speed perturbations. The radiometer is designed for the -10-(+40)°C temperature range. It has a 0.05°C sensitivity threshold and a 50 ms time constant. It covers a 4° wide scan angle and its error of temperature measurement does not exceed 0.1°C. Together with the 280 mm long and 100 mm in diameter housing it weighs 2.6 kg. The data

storage, a 1.8 Mbyte MK60 compact cassette with eight input channels, is designed for a recording frequency of 4 kHz and a recording density of 63 bits/mm. The size of this cassette is 120 x 360 x 480 mm$^3$ and it weighs 6 kg. It requires a 12 V power supply and draws a current of 0.75 A. Figures 1.

## Estimating Target Motion Rate in Sequence of Changing Two-Dimensional Images

[Article by B.A. Alpatov, Ryazan; UDC 629.705:621.391.268]

[Abstract] The problem of tracking area-extensive rather than point targets moving against a complex background in a sequence of two-dimensional images whereby the target position, individual picture element luminance, and the background dimensions and shape may change is formulated and solved as a problem of estimating the target parameters, including the picture element classification procedure. To this end, a state vector is introduced for each background picture element. The solution derived by successive weighted least square error criterion optimization which involves a search for the predicted image at which the best merger with the current image is produced, picture element classification allowing for a change in the target dimensions and configuration, frame-to-frame filtering of the background and target center images, and path filtering of the background and target center coordinates. The specific algorithms for various assumptions may be derived on the basis of these data. It is shown that when necessary, the vector of parameters characterizing the target mass may be introduced and used for solving the pattern recognition problem. References 7.

## Simulating Correlational Real-Time Target Tracking

[Article by V.A. Ivanov, Novosibirsk; UDC 681.3.019]

[Abstract] The task of automatic target tracking—target detection with subsequent calculation of its current position by analyzing a sequence of images—is discussed and characteristic features of the correlational target tracking algorithm realization by a multiprocessor image processing complex (MPK), determining the limits of the multiprocessor image processing complex capabilities, and formulating the requirements imposed on its architecture, hardware components, and characteristics of the elements necessary for developing real time application tracking system are investigated. The method of comparing a "standard" image fragment, i.e., the target image against a certain background, to the "current" image fragment by calculating a certain measure of affinity which is then compared to a given threshold is

considered. The multiprocessor image processing complex components solve the problem of tracking variable targets against a transient background with a digital input data stream of four and eight 256 x 256 pixel frames for the TRC and TRF real time programs, respectively. It is suggested that the target be "centered" in the standard fragment in order to make it possible to ensure the algorithm functioning in the case of frame-by-frame standard updating. References 6.

## Cepstral Analysis of Sea Ice Probing Radio Signals Based on Linear Prediction Method

*927K0196C Novosibirsk AVTOMETRIYA in Russian No 3, May-Jun 91 pp 31-35*

[Article by A.G. Oganesyan, I.B. Chaykovskiy, Lvov; UDC 621.396.95:521.32]

[Abstract] The operating principles of radar sea ice thickness meters (RL ITL)—time division multiplexing of the echo signals from the upper and lower ice surface in order to determine the mutual time shift conveying data on the ice thickness—and its shortcomings related to the limited transparency of ice, making it impossible to use nanosecond probing pulses, are discussed. It is shown that to a certain extent, cepstral methods of digital echo signal processing make it possible to overcome these obstacles. The power cepstrum is determined and fast Fourier transform (BFP) and discrete Fourier transform (DPF)-based computation procedures are derived. To simplify the procedure, the secondary fast Fourier transform is substituted with simulating the log spectrum by the linear prediction method. A block diagram of the module for digital signal processing on a computer is cited and the dependence of standard deviation on the potential for two probing signals, on the number of input data samples for two probing signals, and on the filter order and the echo signal cepstra are plotted. The use of linear prediction in forming the echo signal cepstrum considerably decreases noise and improves the information peak discernibility yet the information peak position shifts, so there is virtually no measurement accuracy gain. A significant accuracy gain may be realized by simultaneously using the echo signal cepstrum accumulation. Data are processed on a YeS-1022 computer with an $8 \times 10^4$ ips speed. Figures 5; references 7: 6 Russian, 1 Western.

## Multilayer Optical Data Recording Method

*927K0196D Novosibirsk AVTOMETRIYA in Russian No 3, May-Jun 91 pp 76-80*

[Article by I.B. Rudakov, I.Sh. Shteynberg, Yu.A. Shchepetkin, Novosibirsk; UDC 681.327.68:621.373.826]

[Abstract] The limitation of bit-by-bit data recording on surface planar media and the requirement to increase the volume of binary data being written prompted an investigation of multilayer writing of data in a bulk thick medium on the basis of selecting a written data volume zone during the subsequent heterodyne data scanning. A block diagram of the multilayer optical data writing device is cited and its operating principle and that of its components are described. The phase difference of two adjacent pits of the spatial diffraction grating is used as the information content value parameter for differential phase modulation. The method is based on synthesizing the pit grating with the help of an acoustooptic modulator and a semiconductor laser and is not critically sensitive to the value of longitudinal (time) coherence of laser radiation and ensures good light utilization and a high mechanical and time stability of the wave front merger of the reference heterodyne and scanned light beams. The minimum dimension of the selection zone depth is close to 4-5 $\mu$m which approaches the theoretical limit. The methods makes it possible to increase the optical recording density by approximately tenfold. Figures 5; references 3: 2 Russian, 1 Western.

## Digital Proximate Energy Spectrum Analyzer

*927K0196E Novosibirsk AVTOMETRIYA in Russian No 3, May-Jun 91 pp 86-89*

[Article by D.Yu. Akatyev, A.N. Kostyunin, Gorkiy; UDC 681.3:519.246.8]

[Abstract] Digital spectral analysis (SA) techniques in general and nontraditional nonlinear techniques based on the entropy minimax method (MME) in particular are discussed and the results of an experimental study of a digital proximate analyzer in which the entropy minimax method is implemented for the first time are reported. A mathematical model of the entropy minimax method is formulated and its digital realization is considered. A block diagram of the proximate spectrum analyzer is cited and energy spectrum estimates are plotted. The results graphically illustrate the superior noise immunity, accuracy, and convergence rate of the entropy minimax method over fast Fourier transform-based spectral analysis methods. Furthermore, the energy spectrum analyzer developed on the basis of the method is characterized by high technical and operational indicators. The use of high-speed IBM PC microcomputers with math coprocessors with parallel computations make it possible to increase the data input rate for real-time processing to 100-200 kHz. Figures 2; references 6.

## Signal Convolver

*927K0196F Novosibirsk AVTOMETRIYA in Russian No 3, May-Jun 91 pp 90-93*

[Article by A.I. Kozlov, Novosibirsk; UDC 621.3.049.771.12:621.396.96(088.8)]

[Abstract] The limitations of digital programmable systolic crystals for two-dimensional convolution of images and the technical difficulties of integrated realization of two-dimensional convolvers due to their complicated

internal structure are discussed and a simple device which performs real-time convolution of variable-format signals and images is outlined; in addition, the design of a 128-bit convolver containing two charge-coupled device (PZS) registers, a multiplying circuit, and metal-insulator-semiconductor (MDP) transistor RAM cells is described. Two operating versions of the device are considered: in the first, a higher processing speed is achieved while the second version helps to minimize computational resources. It's real time speed is 2,500 or 25 frames per second, each containing 32 x 32 or 100 x 100 picture elements, respectively, using an 8 x 8 or 16 x 16 window. Figures 3; tables 1; references 10: 8 Russian, 2 Western.

## Multichannel Acoustooptic Time-Integrating Correlator For Antenna Array Signal Processing

*927K0196G Novosibirsk AVTOMETRIYA in Russian No 3, May-Jun 91 pp 93-95*

[Article by M.G. Vysotskiy, V.P. Kaasik, S.A. Rogov, Leningrad; UDC 621.391:535.241.13:534]

[Abstract] The use of acoustooptic (AO) systems for antenna array (AR) signal processing in general and multichannel time-integrating acoustooptic systems in particular is discussed; a multichannel time-integrating correlator designed for processing signals from two orthogonal linear antenna arrays which is capable of performing parallel scanning of space and determining the signal sources' two angular coordinates in real time is considered. A block diagram of the correlator is cited and its operating principle is described. The multi-channel acoustooptic correlator is designed as an inter-ferometer which contains two optical trains each con-sisting of a laser beam expander, a multichannel acoustooptic modulator, and an astigmatic lens system. The modulators are positioned perpendicular to each other according to the orthogonal antenna configuration. The receiving device—a CCD (PZS) array photodetec-tor—is located in the output plane. The dynamic range and signal/noise ratio of the device are examined. An analysis demonstrates that the dynamic range is higher than that of known time-integrating circuits due to the maxima localization on the photodetector surface corre-sponding to different signals while the signal/noise ratio is also higher than that of single-channel circuits due to the coherent composition of signals from all modulator channels and noncoherent noise composition. Figures 1; references 4.

# Formation of Strong Ultrawide-Band Radio Signals by Sequential Time Compression of Microwave Energy.

[Article by A.N. Didenko, corresponding member, USSR Academy of Sciences, S.A. Novikov, S.V. Razin, P.Yu. Chumerin, and Yu.G. Yushkov, Scientific Research Institute of Nuclear Physics at Tomsk Polytechnic Institute; UDC 621.374]

[Abstract] A method of forming high-power nanosecond radio signals sufficiently wideband within the centimeter-wave range was been proposed by A.N. Didenko and Yu.G. Yushkov in 1984, the method involving time compression of microwave energy in a resonator. The resonator is excited by a relatively weak input signal from an oscillator operating in the continuous or long-pulse mode and stores the incident electromagnetic energy. This energy is extracted from the resonator in a pulse much shorter than the resonator time constant, which makes the peak power of this output pulse correspondingly much higher than that of the input signal. A maximum power gain within the 100-1000 range is attainable with a copper resonator, within the $10^3$-$10^8$ range with a superconducting resonator. A recent original experiment has demonstrated the feasibility of producing ultrawide-band radio signals of about 1 GW power by sequential time compression with a commercial decimeter-wave oscillator as excitation source. In this experiment three 2.82 GHz compression stages were connected in series. The first stage, a conventional copper H-type waveguide T-joint forming a high-Q standard resonator 44 x 72 $mm^2$ in cross-section, was excited by a magnetron oscillator with 1 MW pulses of 3.6 µs duration at a repetition rate of 50 Hz. The following two compression stages were coaxial T-joints which shortened a resonator output pulse to 1.4 ns and then 0.35 ns duration respectively, the magnetron output power thus being successively boosted to 0.312 GW and then 0.63 GW. The second stage operated under atmospheric air pressure. Adequate electric strength of the third stage was ensured by insulating it with nitrogen under a pressure of 0.2 MPa. A ferrite diode and an adjustable phase shifter were used for matching this 3-stage pulse compressing load to the oscillator. After the microwave electromagnetic energy had been stored up, pulses of negative polarity and 10 kV amplitude were applied through a trigger to a discharger in the last stage so as to activate a switch for extraction of 21.7 MW pulses of 30 ns duration (the error of power measurement did not exceed 30 percent). These pulses were recorded with an S7-19 high-speed oscillograph, after passage through a calibrated adjustable attenuator, and their relative bandwidth was found to extend over the 0.5-2 range. Figures 2; references 6.

## Base Designs of Multichannel Transmission Systems

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*in Russian No 1, Jan 92 pp 15-18*

[Article by A.V. Ulyanov; UDC 621.395.37:681.51]

[Abstract] The four generations of base load-carrying structures of multichannel transmission system racks developed and implemented in the past 50 years by the Long-Distance Communications Scientific Production Association are briefly summarized and their applications are outlined. The early designs developed at the Krasnaya Zarya Plant in the 1930's and 40's are mentioned and the 1961 base structure developed for the K-1920 coaxial 1920-channel cable telephone and TV system and V-3-3 aerial three-channel system, the 1969 base structure developed for the K-300 cable system by a cooperative effort of Russian, Hungarian, and German engineers, the 1972 base modular functional structure intended for the K-3600 transmission system which utilizes the advances in semiconductor and integrated circuitry technology and electronic radio items (ERI), and the 1985 base structure—a functionally complete modular design employing printed boards of various dimensions—are described in detail. An analysis of the approaches and design trends of the past fifty years indicates that each subsequent design is often dictated by the development level of the component base and circuitry as well as the capabilities of the equipment manufacturers; each new design is also developed allowing for the advantages and shortcomings of existing systems. Figures 10.

## Development Trends and Design Methods of Wire Transmission System Testing Devices

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[Article by A.Ye. Sukhotskiy, N.A. Borisova; UDC 654.1.011.56]

[Abstract] The importance of the testing devices for improving the quality of wire transmission system (SP) equipment is stressed and the main problems facing the development of a range of testing systems—from dedicated to adaptive automated complexes—are outlined. Testing system are defined as facilities intended for executing monitoring and measurement operations; the process of testing system design on the basis of existing specifications, regulatory documents, and computer and automation system capabilities is considered. The role of computer engineering in the development of testing facilities and the architecture of modern multiprocessor systems used for this purpose are discussed and the unity of CAD (SAPR) and computer-aided control and monitoring systems (SKU) is analyzed. The conformity of testing systems to CCITT (MKKTT) standards and Telecommunication Management Network (TMN) concepts is studied. A block diagram of a prospective adaptive computer-aided control and monitoring system synthesis method on the basis of artificial intelligence elements is presented. It is emphasized that the development of new testing system is characterized by a high degree of standardization and unification and extensive use of computer hardware and software. The need to develop an interdisciplinary knowledge base methodology is identified. Figures 1; references 9: 8 Russian, 1 Western.

## Optical Transistor—New Functional Element of Fiber Optic Transmission System Technology

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*No 1, Jan 92 pp 22-25*

[Article by Yu.L. Bystrov, S.A. Lomashevich, Yu.V. Svetikov; UDC 681.7.068]

[Abstract] A new trend in today's fiber optic transmission system (VOLS) development—the emergence of optical signal generation and processing methods and optical amplifiers—prompted the development of a new functional element of fiber optic transmission systems: an optical transistor (OT) whose operation is based on the phenomenon of optical bistability (OB) in semiconductors. Consequently, the concept of optical transistor design and its operating principle are examined in detail. The physical phenomena which underlie the optical transistor operation—optical bistability developing in nonlinear media with feedback—are analyzed and a block diagram of an optical feedback-based optical transistor is cited. The use of a Fabry-Perot interferometer as a design element of optical transistors is considered and its transmission function is derived. The optical transistor combines in a single optical system a phase modulating (FM) control cell, a distributed or lumped pump source, and a resonance cavity (RP) which responds to the input signal and generates the output radiation. Optical transistors can be used for developing optical processors for optical computers and for forming switching integrated optics arrays; they have an optical radiation gain on the order of $10^3$-$10^4$ and are capable of multimode operation. An optical transistor splitter has been successfully developed and its implementation is expected in 1992. Figures 4; references 12: 3 Russian, 9 Western.

## Small Infrared Lenses for Fiber Optic Data Transmission and Processing Systems

*927K0210D Moscow ELEKTROSVYAZ in Russian*
*No 1, Jan 92 pp 25-26*

[Article by T.V. Basistova, T.N. Vashchenkio, A.L. Dmitriyev; UDC 681.7.067.2.28]

[Abstract] The shortcomings of existing compact collimating objective lenses which limit their applications in wide-band optical signal transmission and processing systems prompted the Long-Distance Communications Scientific Production Association to develop the MOK-85 and MOK-89 dedicated collimating lenses specifically

intended for use in fiber optic devices with semiconductor light sources (lasers), unimodal and multimode optical fibers, and thin film waveguides. The design and optical characteristics of the new infrared lenses are discussed and their specifications are summarized. The lenses which operate within a 0.50-1.80 μm wavelength band are used for developing optical deflectors and holographic infrared demultiplexers with a high spatial resolution. A software routine which makes it possible to design the necessary optical and mechanical lens parameters on the basis of the relative aperture, focal length, working wavelength ratio, aberration, and other data is developed. The lenses are expected to enter commercial production in 1992. Figures 3; tables 1; references 8.

## 'Zharyk' Satellite TV System for Kazakhstan

[Article by V.L. Bykov, Ya.L. Dribinskiy, L.Ya. Kantor, B.A. Lokshin, I.S. Povolotskiy, A.M. Tungushbayev; UDC 621.396:677.32]

[Abstract] The urgency of improving regional and republican TV programs by further upgrading the network of radio relay links and developing satellite TV (STV) systems in the 12 GHz band on the basis of the Gals and Gelikon type satellites is discussed and stage-by-stage realization of such a system with the help of the Zharyk (light in Kazakh) ad hoc system is outlined. The principal specifications of the 11/14 GHz Zharyk system operating in baseband channel 12 (Luch registration index) of the Gorizont satellite and the quality indicators of the Zharyk system channels are described. A system coverage map and its block diagram are cited and its electromagnetic compatibility (EMS) with other systems is summarized. The equivalent isotropically radiated power (EIIM) on the coverage zone edge is 36.8 dBW and the power flux density (PPM) on the coverage zone edge is close to -126 dBW/m². The Zharyk system was brought on stream commercially in December 1990 and has 10 earth stations with 4 and 4.5 m dia. antennas located on the periphery of the republic. Figures 3; tables 1; references 3.

## Radio Visibility Zone Analysis of Satellite Communication Systems Based on Satellites Placed in Various Types of Orbits

[Article by A.A. Akimov, A.M. Anosov, G.S. Gusakov, A.V. Kolesnikov (deceased), L.A. Sakhnin; UDC 629.783]

[Abstract] The peculiar geographic position of the USSR which hinders the use of satellites in geostationary orbits (GO) for radio traffic over the entire territory necessitates the use of communications satellites in circular and elliptical orbits. A procedure is developed which makes it possible to use the characteristics features of radio visibility zone analysis for multibeam antennas (MLA) and phased antenna arrays (FAR) in order to align them and select their boresight direction. The procedure makes it possible to extend a known algorithm to satellites moving in random orbits. It is realized as a microcomputer program which enables us to analyze the radio visibility zones of satellites equipped with antenna systems of any design and placed in various types of orbits and project these zones onto a map. Visibility zones of the prospective Marafon satellite communication system (SSS) equipped with a phase array and of the 127-beam antenna located on a satellite in a circular orbit are shown and compared to 12 consecutive positions of the coverage envelope of the same antenna located on a satellite in an elliptical orbit. An analysis of the coverage zones indicates that in using multibeam antennas in satellite-based repeaters, it is necessary to compensate for both the translational motion of the coverage zone and its axial turn due to the earth's rotation and satellite motion. Figures 5; references 6.

## Polarization Fading Compensation During Ionospheric Propagation of Decameter Waves

[Article by I.S. Falkovich; UDC 621.371.25:621.391.242]

[Abstract] Methods of compensating for the polarization fading which cannot be eliminated by narrowing the antenna beam even to 1°, since the difference in the angles of arrival of the ordinary and extraordinary waves over extended paths is, as a rule, smaller than 1°, are considered and the design of a matched polarization filter—the principal device which realizes polarization discrimination of the waves and composes the signal components received by orthogonally polarized antennas—is described. The efficiency of the polarization filtering methods (selecting a single magnetoionic component, suppressing the second "interfering" component on the polarization filter (PF) output, and adaptive polarization filtering of the composite filed), the effect of the magnetoionic wave parameters on the polarization processing efficiency, the effect of the earth on the polarization discrimination efficiency, and the fluctuation sensitivity of polarization processing methods are discussed. An analysis shows that adaptive polarization filtering is optimal if the field is formed by a combination of two magnetoionic components of a single ionospheric beam. Polarization filtering of one wave is inferior in efficiency to adaptive polarization filtering while a transition from an adaptive polarization filter to post-detector composition of signal envelopes does not noticeably worsen the processing results. The two principal polarization bases are compared; the comparison shows that the use of the circular basis in the case of quadrupole propagation results in a smaller residual signal fading depth. Figures 1; tables 1; references 4.

## Effect of Underlying Surface Conductivity Variations on Medium and Long Wave Ground Wave Strength Amplitude

[Article by V.N. Zakharenko; UDC 550.372+621.391.812.61(571.11/571.17)]

[Abstract] The fallacy of the commonly made assumption that the electric conductivity of the underlying surface remains constant during an extended time span due to the independence of the radio field strength and ambient air temperature is pointed out and an attempt is made to establish the correlation between the air temperature and electric conductivity and the relationship between the field strength and temperature in the medium and long wave bands. The problem is formulated and the results of experimental observations with the help of FSM-11 and Schlumberger equipment using a standard procedure are reported. An analysis of the experimental findings make it possible to establish the correlation between the air temperature and the underlying surface conductivity and, consequently, between the temperature and radio field strength amplitude in a 100-1,000 kHz band. In a first approximation, the temperature vs. field strength relationship is expressed by the formula $E=C \arctan t°$ where $C$ is a correction factor determined empirically for each frequency. Radio wave field strength changes lead to significant coverage boundary variations which must be taken into account in order to eliminate interference among proximate radio stations. Figures 8; references 6.

## Pulse Response of Urban Radio Channels in VHF Band

[Article by V.N. Abarykov, V.K. Alekseyev, I.G. Afanasyev; UDC 621.391.272:621.396.237]

[Abstract] The constantly changing propagation conditions in urban radio communications make it difficult to predict reliable operation and necessitate experimental measurements of the spatial pulse radio signal structure under varying reception conditions in order to assess the multipath characteristics of urban radio channels in the meter wave band with respect to delays and component beam strength. To this end, a pulse test signal is generated at the 16th line of the composite TV signal and is radiated by TV transmitters during the broadcasting of central and local TV programs. The test signal is formed by two short rectangular positive polarity signals with a 1 μs duration spaced by 24 μs from each other and 16 μs from the leading edge of the line sync pulse. The experimental measurements are taken in Ulan-Ude, Tula, and Irkutsk and the experimental data are processed on an Iskra-1030 microcomputer. An analysis of the findings demonstrates that the percentage of realizations with one or several delayed pulses observed separately is relatively low and largely depends on the threshold level. A comparison of the results shows that the amplitude level of the delayed signal extraction also determines the magnitude of the recorded time delays. The principal array of the delayed pulses at a level above -20 dB falls within a 2-8 μs delay interval with a mean intensity minimum of about 4 μs. It is shown that the data may be used for developing digital mobile radio communication systems. Figures 5; tables 2; references 1.

## Methods of Estimating Reliability of Complex Electrical Systems

[Article by I.I. Kartashev, candidate of technical sciences, and Yu.A. Fokin, doctor of technical sciences; UDC 621.311.019.34.001.24]

[Abstract] One of the reports of Research Committee Group RC-38 to each of the two CIGRE conferences in 1988 (Paris) and in 1990 (Montreal) dealt with reliability of complex electrical systems, their reliability being estimated at three hierarchical levels: I) electrical energy generation system; II) electrical energy generation and transmission systems; III) electrical energy generation, transmission, and distribution systems. To the third level, which accordingly covers most complex electrical systems, has been recently applied the concepts of "resultant reliability". Reliability analysis of such systems is concerned with two particulars. The first one is adequacy, i.e., preparedness to ensure continuous supply of electrical energy supply to users according to established specifications even in the event of failures in any of the three component systems, in balanced systems this being referred to as static or structural reliability. The second one is security or viability, i.e., preparedness to withstand suddenly arising fault conditions, this being referred to as dynamic reliability. It includes integrity, i.e., ability of the system to continue supplying electrical energy to all customers without block-by-block cutoffs. Estimation of the resultant reliability implies a probabilistic approach to the problem. This approach requires selection of system performance indicators at risk and their numerical evaluation on the basis of appropriate models, establishment of reliability and failure criteria, and reduction of the system to an equivalent simpler one for maximum computer memory and time economy. Interesting is how the "n-1" rule can be used differently than in the deterministic approach to reliability analysis. Two methods of estimating the adequacy, i.e., structural reliability of complex systems abroad are the "sifting of states" method (U.S., Canada) and the Monte Carlo Method (France, Italy, England, Brazil). It is important that the cost of reliability assurance be included in planning of complex systems. This is done best by either comparing separately the installation costs and the operating costs of proposed equally reliable variants of, say, a new power plant or by comparing their total installation and operating costs plus costs of reliability assurance. Numerous programs for reliability calculations are available and their number continues to increase, different programs being based on different load distribution and fault countermeasure models and different risk indicators. An important factor accounted for in each new program now appearing is the latest state of the art in reliability technology, particularly in semiconductor power hardware and in information management. References 2.

## Flashover Characteristics of Shield-to-Ground Air Gaps During Surges of Switching Overvoltages

[Article by G.N. Aleksandrov, doctor of technical sciences, and A.I. Afanasyev, candidate of technical sciences, Leningrad State Technical University; UDC 537.521.6:621.31.015.33]

[Abstract] Flashover across shield-to-ground air gaps during surges of switching overvoltages was studied in a an experiment simulating the characteristics of base insulator systems for extra-high-voltage substation equipment. The experiment was performed on the outdoor test yard at the Extra-High-Voltage Laboratory of the Leningrad State Technical University. A surge generator storing up to 560 kJ energy served as the source of 7.0 MV total charging voltage. It could be regulated for delivery of four different exponentially decaying voltage pulses with following rise time and fall time (to half amplitude): 1) 160 $\mu$s and 1560 $\mu$s, 2) 300 $\mu$s and 2520 $\mu$s, 3) 520 $\mu$s and 2510 $\mu$s, 4) 980 $\mu$s and 4570 $\mu$s. Toroidal shields made of aluminum tubing with a 4.5 cm inside radius were used in the experiment, the radius of curvature of their circular axis ranging from 0.5 m to 2.0 m. The shields were suspended from a chain of glass-plastic thin insulator rods with skirts, its altitude above ground being varied from 1.0 m to 26.0 m by means of an electrically driven windlass. Extraneous objects were at least 32 m away from the axis of an air gap. Voltage was applied to each shield through a stub consisting of a 35-40 m long sloping segment and a 5-7 m long vertical one. Tests were performed at several points, at least four, at least one flashover being recorded within a series of 25-100 tests. Tests were performed with surges of both positive and negative polarities, and the atmospheric conditions were monitored throughout the entire testing period: the pressure varying over the 99.4-102.2 kPa range, the temperature varying over the -8-(+27)°C range, and the humidity varying over the 45-80 percent range. With the discharge voltages reduced to normal atmospheric conditions according to the applicable 1976 All-Union State Standard, the 50 percent discharge voltages $V_{0.5}$ and the coefficient of variation $\sigma^* = \sigma/V_{0.5}$ ($\sigma$-standard deviation) were evaluated by the method of least squares, with a 2.0-4.0 percent error and a 20-40 percent error respectively. Surges of positive polarity and surges of negative polarity are considered separately in the analysis of the respective data for dependence of $V_{0.5}, \sigma^*$ and the mean predischarge time $t_{0.5d}$ on the gap length (distance from shield to ground), dependence of $V_{0.5}$ on the rise time of surges, dependence of the total charge on $V_{0.5}$, and dependence of total capacitance $C_{0.5}$ of the high-voltage electrode (shield) on the mean electric field intensity in each case. On the basis of these relations are determined the minimum discharge voltage $V_{0.5min}$ and the corresponding critical rise time of a surge. These relations are also approximated with semiempirical engineering formulas for design purposes. The results indicate that in this experiment the 50

percent discharge voltage increased linearly as the gap was lengthened, by 0.05-0.1.6 MV/m under switching surges of positive polarity, and was at least 1.9 times higher under switching surges of negative polarity. As the gap was lengthened, the coefficient of variation peaked to a maximum at a gap length of approximately 2 m under surges of all the four different forms and dropped to a minimum throughout the linear range of gap length dependence on the surge time rise. Figures 7; tables 3; references 20.

## Invariant Transformations of Transforms of Linear Signals

[Article by A.S. Shatalov, doctor of technical sciences, Moscow; UDC 621.372.001.57]

[Abstract] The expansion theorem is applied to the Laplace transform $X(p) = P(p)/Q(p)$ of a compound signal, where $P(p)$ represents a polynomial and the $Q(p)$ polynomial has been factorized, so that this quotient becomes converted into the sum of two series. This requires procedures $X_{2(\rightarrow)}$ $1/(p-\lambda)$ and $x_2(\rightarrow)$ $e^\tau$, both involving the $\Lambda$-operator $X$ $(\rightarrow)$. Invariance of this operator in the four scalar domains $t,p,j\omega,z$ has already been established. Other invariants are found upon vector representation of such signals in the phase, recurrence, mode, or any other space of states. A table of rows and columns is set up which conveniently pairs transforms and originals in five domains in accordance with the invariance principle, the fifth domain in addition to the $t,p,\omega,z$ domains being the other time domain orthogonal to the time domain of originals. Transformations and inverse transformations of a signal from one domain into another, according to that table and with the appropriate matrix of weight coefficients, are demonstrated on a signal representable as the sum of two series: of $Ae^{\lambda t}$ terms and one of $At^\nu e^\tau$ terms respectively. The solution of problems occurring in transient and spectrum analyses is then demonstrated on five examples: 1) with the aid of a Laplace transformation, find the frequency spectrum of a modulated signal $x(t) = \sin(v_1 t + \psi_1) \sin(v_2 t + \psi_2) 1(t)$ whose frequencies $v_{1,2}$ and phases $\varphi_{1,2}$ are known; 2) find the initial values of that signal in the phase space from its transform $X(p) = (5p^5 + 40p + 130)/(p+1)(p+2)(p+3)$ and then, with the aid of Vandermonde's matrix, expand that transform into modes; 3) find the original from its transform $X(p) = (5p^3 - 2p^2 + 2p - 20$; 4) to find the envelope of that signal in discrete segments of 0.5 s duration each in the z-transform representation; 5) knowing the denominator $Q(z)$ of a z-transform, reconstruct its numerator $P(z)$. Figures 2; tables 1; references 5.

## Dynamical Equation of Helical-Strip Capacitive Integrator

*927K0195A Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 10, Oct 91 pp 5-16*

[Article by E.V. Kolesnikov, Volgograd University; UDC 621.3.011+538.311]

[Abstract] A helical two-wire line with capacitive and inductive turn coupling made from two conducting strips interleaved with insulator layers, rolled into a helical coil, and used as a capacitive energy storage, i.e., a capacitor is considered and the algorithm for analyzing radially symmetric oscillatory processes in such a line used as a capacitive integrator is derived. The transient processes in the line are examined in two discharge modes: the regular discharge of the strip line into a given load and its operation as a voltage pulse generator (GIN) described by R.A. Fitch. It is assumed for the purpose of analysis that the magnetic field in the coil is axial and that Ampere's circuital law is applicable. The integral and differential equations of the line are derived allowing for the skin effect in the strips and dielectric losses and the helical strip line equations are solved in an operator form. To this end, general solutions of the differential equations are first found, then partial solutions are found in the form of a power series. The integrator's voltage between the turns and equivalent operator parameters are calculated, making it possible to consider the charge integrator as an active one-port. Figures 7; references 4: 3 Russian, 1 Western.

## Dynamical Equation of Helical-Strip Inductive Integrator

*927K0195B Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 10, Oct 91 pp 17-26*

[Article by E.V. Kolesnikov, V.V. Podgornyy, Volgograd University; UDC 621.3.011+538.311]

[Abstract] An inductance coil wound from thin conducting and insulating interleaving strips which is distinguished by low skin-effect losses since its magnetic field has primarily the axial component tangential to the strip is considered. The characteristics of the pulse generated by the inductive strip integrator discharging into a given load (used as a generator of high-voltage pulses with high-resistance loads) as well as its coil-to-coil voltage are examined. The electromagnetic induction equation, the current continuity equation, and the differential and integral equations of the strip coil current density are derived and solved. The integrator load voltage is calculated and the strip coil's magnetic permeability is analyzed in an operator form, making it possible to represent the strip coil as an active one-port. Figures 3; references 3.

## Controlling Electric Power Demand of Gas Industry Enterprises

*927K0195C Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 10, Oct 91 pp 104-107*

[Article by V.I. Dobrozhanov, N.I. Dobrozhanova, Orenburg Polytechnic Institute; UDC 621.316.7]

[Abstract] The issue of increasing the power demand efficiency and refining the efficiency criteria is addressed and the problem of controlling the power demand by regulating the electric power consumption is formulated. An analysis of the power demand of the gas industry enterprises vs. their installed capacity reveals considerable hidden reserves for lowering the energy consumption. A method of selecting the specific processes which may be used as power consumption regulators is considered; in order to minimize the effect of power demand regulation on the product quality, paired correlations are used to estimate the constraint force between the electric load of process installations and the individual types of items they produce; in so doing, installations with a weak constraint between the production of ready items and electric power consumption are selected. Studies were carried out at the gas and stable condensate processing installations at the Orenburg Gas Processing Plant; amine pumps and propane compressors were considered as the electric load. Paired correlations between the product output and electric load are established as a result. The conclusion is drawn that the electric load of individual process installations is not rigidly connected to the output of production, so these installations may indeed be used as users-regulators during the limited electric power consumption hours (peak demand hours) with the least detriment to the product quality. Figures 1; references 2.

## Synthesis of Multilayer Wide-Band Metal-Insulator Coats

[Article by N.V. Grishina, Mathematics Department; UDC 535.417]

[Abstract] The peculiarities and problems of synthesizing multilayer metal-insulator systems due to the need to take into account absorption and the dispersing properties of metals, i.e., consider complex values of the refractive index whose imaginary part—the extinction coefficient—is responsible for absorption in a given material, and take into account the dependence of the refractive index and extinction coefficient on the wavelength as well as the difficulty of selecting materials with a given sequence of layer refraction indices are considered. Synthesis of wide-band metal-insulator coats with specified spectral properties is considered and high-quality heat-reflecting cut-off filters containing alternating Ag and Cu layers and coats with a low reflectance and a close to 10 percent transmission in the visible spectrum containing Ni layers are synthesized. Effective recursive formulas are derived and used for analyzing the spectral coefficient derivatives while dispersion and absorption are specified either analytically or in a tabular form. Figures 3; tables 1; references 10: 7 Russian, 3 Western.

## Single Approach to the Evaluation of the Sensitivity and Resolution of Image Receivers

[Article by B. E. Bonshtedt and Yu. A. Gololev, Vavilov State Optical Institute; UDC 621.391.8]

[Abstract] Different image receivers (photographic, electro-vacuum, solid state) have different sensitivities and resolutions, and the methods of determining these parameters for different receivers are themselves varied. Hence, it is difficult to compare different types of receivers. The use of the parameter $D^*$ for infrared equipment is discussed. This parameter links signal level, receiver size, and noise level, but is inappropriate for visual equipment because of the great variations in contrast. The authors propose the use of a sensitivity parameter C for the visual range that is the inverse of the amount of light energy received by one resolution element at a specific level of input contrast. Equations are derived to define C. A graph of the sensitivity of image receivers versus contrast is given. There is also a graph of the sensitivity, resolution and contrast for an ideal semiconductor receiver. The advantages of certain types of receivers under certain conditions are compared. Figures 2.

## Device and Recording Media for Express Output of Semitone Images from a Computer

[Article by V. N. Bolshakov and M. A. Goryayev, Vavilov State Optical Institute; UDC 772.9]

[Abstract] The hard-copy output of images from a computer can be divided into two resolution quality levels: visual quality (7-10 $mm^{-1}$, the limit of the human eye) and reproduction quality (up to 100-300 $mm^{-1}$). This article discusses printers and media for the output of these images. Gradation scales and printing methods are described. The most promising method of obtaining semitone images from a computer is photographic recording with a laser or another light source on a light-sensitive material. The main reason traditional photographic media are not used is the involved and lengthy liquid chemical processing procedure. In response to this, new washless processes and diffusion materials were developed by Polaroid. However, the most widespread method uses Dry Silver, which is developed by heating to 110-150°C for several seconds. A schematic of a typical printer using this thermal developing material is presented. Specifications of Dry Silver media are presented, as well as a description of how the process works. Conditions for the use, exposure, and processing of Dry Silver materials are discussed. It is noted that these materials can be made sensitive to any area of the spectrum from dark blue to the near infrared. The adverse effect of temperature change during processing is discussed. Implementation of appropriate processing conditions in printers is described. The recent development of color Dry Silver materials is hailed and specifications given. Figures 2; tables 2; references 26: 7 Russian 19 Western.

## Opto-Mechanical High-Speed Photography Systems in the USSR

[Article by A. S. Dubovik, Moscow Institute of Geodesy, Aerial Photography, and Cartography; UDC 778.534.83:535.31]

[Abstract] Means of monitoring fast proceses in science and technology are becoming more and more important. The traditional method of studying such processes has been high-speed photography. This article begins with an overview of the history (in imperial Russia and the USSR) of the development of opto-mechanical systems to study fast processes and measure their optical and physical parameters. Today's high-speed photography systems are divided into four types: high-speed movie cameras with continuous film movement, high-speed movie cameras with optical compensation of film movement, reflex cameras and photochronographs, and reflex cameras and photochronographs free of

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chromatic aberration operating in the UV to IR range (0.2-20 µm). Specific examples of each type, photographs of the equipment, and specifications are presented. Special features of each model are discussed. In conclusion, the author notes the processes and materials used abroad which must be introduced into practice in the USSR, namely, processes involving small exposure times ($10^{-3}$-$10^{-6}$ s), CCD structures to record single-frame and multi-frame photographs, and television equipment operating at 1000-20000 frames/second. Figures 10; references 8: 7 Russian 1 Western.

## Basic Principles for the Construction of Automatic Image Deciphering Systems

[Article by S. A. Ivanov and A. F. Mozhayskiy, Military Engineering and Space Institute; UDC 681.783.335:681.5]

[Abstract] The vast amount and rapid acquisition of remote sensing data has created a need for automated image deciphering systems. This article discusses the basic principles involved in the creation of such a system. Deciphering involves detection of typical objects of observation, determination of their location, and calculation of their characteristic parameters. Unlike traditional methods which comprehend the image as a whole first, this system would isolate individual objects for analysis. The approach is narrowly focused and subject-oriented. Consequently, the system must have abundant *a priori* knowledge on the following: the subject matter, means of image acquisition, image processing procedures, information on the transmission, storage and representation of video files, and the system itself. The example of recognition of an airport and its various facilities is used. Flowcharts are presented to outline the deciphering procedure, one of increasing refinement of knowledge. The advantages of an adaptive system are discussed. The system should be constructed according to the principle of the hybrid expert system, one which can synthesize knowledge on the basis of *a priori* knowledge. A flowchart of a proposed system is presented. The system would include a smart terminal, knowledge base, operating system to control deciphering, and programs and special processors to process the images. Figures 3; references 10 (Russian).

## Some Problems Which Arise in the Construction of a Three-Dimensional Model of Artificial and Natural Objects With a Computer

[Article by K. M. Vinogradov, S. V. Dmitriyev, I. A. Malyshev, and Yu. A. Panov, Vavilov State Optical Institute; UDC 528.72:681.322]

[Abstract] When constructing models of areas with buildings and other structures from photographs, one must measure geometrical parameters of the objects in the scene. To do this one has to transform the images, combine images with different geometries, and then measure the parameters. This article describes a method of computer processing which transforms images, automatically combines them, and measures parameters of objects in the photos. The method uses transformation by known points. To combine photos, a method which automatically isolates angular points was developed. The article also presents results of a study of methods of measuring height with modeling figures (in particular, a parallelepiped) and shadows. The methods were tested on a computer. The initial image is displayed on a terminal with the image to which the first photo should be linked. The cursor is used to give the coordinates of the points of the initial image, then in the same order, the coordinates of the corresponding points of the second image. The images are given by brightness distribution functions. The functions are interpolated and an algorithm performs linear and nonlinear transformations. For images with 256 x 256 pixels and 49 pairs of points, the program takes one minute. For an image with $r X r$ pixels and for $N$ pairs of points $14 Nr$ additions and $2 Nr$ multiplications of real numbers are performed. This method reduced distortions by a factor of three. Figure 1; references 10: 7 Russian 3 Western.

## Estimate of the Accuracy of Reestablishing a Wave Front With Adaptive Phase Conjugated Optical Systems

[Article by S. V. Butsev and V. Sh. Khismatulin, Govorov Military-Engineering Radiotechnical Academy, Kharkov; UDC 681.7.062.47]

[Abstract] Adaptive optical systems have been proposed to effectively compensate for light signal distortions caused by a turbulent atmosphere. These systems can operate in real time. However, in astronomical observations the incoming light signal is weaker, and compensation errors may arise due to the quantum fluctuation of the signal. Thus, there is interest in evaluating the potential of phase conjugated adaptive optical systems, which are used to measure distortions in a Hartman type wave front sensor. Evaluation of image quality, measurement accuracy, measurement error dispersion, the minimum signal to noise ratio, and the brightness of the object are discussed. Information from the output of the wave front sensor is used to reestablish a wae front. For an input sensor aperture of 15 cm, the adaptive optical system can detect a fourth magnitude astronomical object. Accuracy in reestablishing the wave front can be increased by optimization of the algorithms to a stochastic structure of atmospheric distortions. Also, individual phase differences from the wave front sensor are

not used; rather a wave front state evaluation is used with a dispersion of values. With these modifications, for a 15 cm aperture the system can now detect up to a seventh magnitude astronomical object. Figure 1; references 6: 3 Russian 3 Western.

## Optimal Structure of a Multi-Element Photoreceptor for a Scanning Pulse Laser Locator

[Article by V. P. Kostin, Kiev Higher Military Aviation Engineering School; UDC 621.383]

[Abstract] In a scanning pulse laser locator, the search for point targets in a given region of space is done with a receiving system with a multi-element photoreceptor. The field of vision of the photoreceptor is taken to be equal to the divergence angle of laser radiation. Typical methods of improving the characteristics of the receiving system are not well suited to laser locators. Analysis of competing factors affecting the quality of detection shows that there should be an optimal correlation between the size of the photosensitive elements, the measurement gap, the size of the scattering circle, and the level of internal and external noise. This article develops a method of determining the optimal structure of a multi-element photoreceptor in which the maximum probability of target (signal) detection is achieved in a scanning pulse laser locator for a given probability of false alarm. It was established that the optimal area over a wide range of parameter variations is several times larger than the area of the scattering circle. The method developed here makes it possible to estimate the unconditional probability of detecting a target with a scanning pulse laser locator with a multi-element photoreceptor. It is also possible to determine the optimal correlation between the size of the elements, the measurement gap,

the size of the scattering circle, and the noise level. It was found that square or hexagonal elements were preferable to rectangular ones. Figures 3; references 4 (Russian).

## Effect of Gamma Rays on the Light Transmission of Fiber Bundles of Very Pure Silicate Glass

[Article by S. V. Danilov, N. G. kotelevskaya, V. I. Skorospelova, S. A. Stepanov, N. A. Khalyavka, and V. Kh. Yagmurov, Vavilov State Optical Institute; UDC 66.018:681.7.068.13]

[Abstract] This article discusses a change in the spectral properties of fiber optic bundles made of especially pure borosilicate glasses when they are irradiated with gamma rays. The initial glasses contained a variable amount of $CeO_2$ (0.1-1.2 percent by mass). The smallest absorption (on the order of 100-300 dB/km) was obtained in the near infrared ($\lambda$=1.06 $\mu$m). The fiber diameter was 25 $\mu$m, the borosilicate glass casing was 4 $\mu$m thick. Bands 2 mm in diameter and 1.0-3.5 m long were used. The lightguides were irradiated by a $Co^{60}$ gamma ray source with $10^4$-$10^6$ R doses at 200 R/s at 20°C. An increase in the $CeO_2$ concentration leads to a shift in the shortwave transmission limit in the red. The sharpest shift in the transmission limit of the bundle was observed at a $CeO_2$ concentration of 0.6-1.2 percent by mass. It was found that for each dose and for given wavelengths the optical absorption decreased exponentially as the concentration of $CeO_2$ increased. Increasing the dose of radiation to $10^5$ R leads to a significant increase in absorption in a glass core with a $CeO_2$ concentration of 0.1-0.4 percent. At doses of radiation above $10^5$ R the absorption increases linearly as the logarithm of the dose increases. The angle of the slope decreases as the concentration of $CeO_2$ increases. Figures 4; references 2 (Russian).

## Electronization Development of External Computer Storage Using Semiconductor and Magnetic Chips

[Article by P.P. Maltsev, N.V. Prudnikov, V.K. Rayev, Control Computers Institute; UDC 621.382]

[Abstract] The irreversible process of the shifting microcomputer (PEVM) demand and the increasingly stringent requirements for miniaturizing external computer (EVM) storage quickened the pace of external storage electronization with a high scale of chip integration. The development trend is analyzed in the light of the emergence of ferroelectric nonvolatile CMOS (KMOP) structures and high-density magnetic bubble/vertical Bloch line (VBL) chips. An early trend toward undermining the magnetic disc monopoly and substituting disc with magnetic bubbles (TsMD) is identified; it is shown that today, production of semiconductor and magnetic chips with a 4-16 Mbit capacity and extensive uses of wafer-scale integrated circuit chips in "electronic" discs threatens to displace not only magnetic disc but also optical discs. The parameters of static and dynamic RAM chips and reprogrammable memories are cited. It is noted that the availability of the necessary raw materials and intellectual resources as well as engineering advances in the USSR increase the urgency of developing a comprehensive goal-oriented program aimed at external computer memory electronization. Figures 2; tables 6; references 19: 4 Russian, 15 Western.

## Stable Operation Domain of Magnetic Bubble Shift Channels Based on Asymmetric Chevrons

[Article by V.A. Skidanov, Scientific Research Institute of Materials Science; UDC 621.382]

[Abstract] The difficulty of ensuring the widest stable operation domain (OUR) in designing magnetic bubble (TsMD) devices is discussed and the results of an experimental examination of the performance patterns of magnetic bubble shift channels as a function of the control element asymmetry and the gap between the permalloy layer and the epitaxial ferrite garnet film (EFGP) spacer are reported. The effect of the photolithographic characteristic shape distortion of the controlling element on the stable operation domain of the shift channel and the effect of the geometric parameter correlation on the bubble-bubble interaction in the shift channel are examined and general recommendations are formulated for developing shift channels on the basis of asymmetric chevron structures. The significant effect of the repulsing pole of the adjacent application on the magnetic bubble shift in the yielding part of the element, which is reinforced by a decrease in the gap between the applications and an increase in the elements' asymmetry and distance from the epitaxial ferrite garnet film, is

established and the forces necessary for ensuring a wide stable operation domain in the shift channel are determined. These forces have little effect on the manufacturing spread of the gap sizes, layer thickness, or lithographic distortions. Reliable data storage immune to power failure—the nonvolatile property—is ensured by the chevron height and the presence of a massive receiving end as well as the application vertex angle. The author is grateful to V.P. Kuleshov, Ye.S. Labutin, O.V. Lebedeva, A.V. Surina, and A.A. Ukolov for making the experimental samples. Figures 6; references 8: 3 Russian, 5 Western.

## Cartridge Magnetic Bubble Storage: Development Experience

[Article by A.B. Belkevich, S.O. Kuznetsov, A.A. Lanko, M.A. Shubin, Control Computers Institute; UDC 621.382]

[Abstract] Expanding uses of magnetic bubble-based storage (TsMD ZU), particularly in numerical control machine-tools, remote terminals, robots, and geophysical devices are discussed and the methods and techniques for designing cartridge magnetic bubble storage developed at the Control Computers Institute are outlined. Block diagrams of a Domen-10 magnetic bubble storage, magnetic bubble storage controller, magnetic bubble cartridge, and magnetic bubble storage power supply systems for portable and desk-top versions are cited and the design and operating principles of the principal magnetic bubble storage components is described. The principal specifications of Domen-5, Domen-6, Domen-8, Domen-7, and Domen-10 magnetic bubble storage are summarized. Figures 5; tables 1; references 5.

## Dynamic Effects Leading to Magnetic Bubble Chip Errors

[Article by I.V. Kolchanov, L.N. Prokhorov, V.K. Rayev, Control Computers Institute; UDC 681.327.664.4]

[Abstract] The physical origin of magnetic bubble chips (TsMD MS) is discussed and attention is focused on the error mechanism predicted in 1981 by Rayev and Khodenkov (*Tsilindricheskiye magnitnyye domeny v elementakh vychsilitelnoy tekhniki,* Moscow: Energoizdat, 1981); the behavior of a moving pair of magnetic domains in an environment of transient thermal conditions in magnetic bubble storage is experimentally investigated; the study demonstrates the existence of the dynamic erasure and written data disintegration effects caused by interbubble interactions leading to chip errors. The results help to clarify the mechanism of error

development near the left lower stable operating domain bound of the magnetic bubble storage array. The shift or separation of the second bubble from the pair near the lower stable operating region bound and the pseudocollapse of the fist one are established. The need to examine the pseudocollapse of the first bubble in the shifting pair is recognized and it is suggested that the possibility of the stable operating domain constriction as a result of the above dynamic effects be taken into account in conducting tests and compiling test sequences and procedures. Figures 1; tables 3; references 14: 13 Russian, 1 Western.

### Investigation of Vertical Bloch Line Memory Storage Failure Mechanisms

[Article by S.Ye. Yurchenko, G.Yu. Zharov, Control Problems Institute; UDC 621.382]

[Abstract] The factors affecting the vertical Bloch line (VBL) data storage reliability are discussed and likely mechanisms of storage failures in a vertical Bloch line storage register are investigated; for this purpose, the storage failure is defined as the appearance of spurious vertical Bloch lines in one or several storage registers, annihilation, or loss of synchronism, i.e., breakup of synchronous vertical Bloch line shift from one potential trap to another with each control magnetic pulse. Under the effect of biasing magnetic field pulses on the system of strip domains (PD), flexural domain distortions may develop and persist in the static condition. The development of such distortions is responsible for two new data failure mechanisms related to the loss of vertical Bloch line shift uniformity along the domain walls (DG) and the development of spurious vertical Bloch lines in bent domain wall sections. High-speed photography is used to study the spurious vertical Bloch line nucleation. It is noted that the vertical Bloch line shift nonuniformity is due to the asymmetry of the potential relief stabilizing the strip domains, incorrect strip domain orientation in the film plane, and variations in the ferrite garnet (FG) parameters, primarily the coercive force. One possible way of avoiding the effect of the domain wall shift irregularity and dynamic flexural strip domain instability is to use planar magnetic field pulses for moving the vertical Bloch lines. Figures 2; references 7: 3 Russian, 4 Western.

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